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1.

Migration of Nymphalidae (Nymphalinae), Brassolidae, Morphidae, Libytheidae, Satyridae, Riodinidae, Lycaenidae and Hesperiidae (Butterflies) Through Portachuelo Pass, Rancho Grande, North-central Venezuela.[1]

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(Plates I & II).

[This is one of a series of papers resulting from the 45th, 46th and 47th Expeditions of the Department of Tropical Research of the New York Zoological Society, made during 1945, 1946 and 1948, under the direction of Dr. William Beebe, with headquarters at Rancho Grande in the National Park of Aragua, Venezuela. The expeditions were made possible through the generous cooperation of the National Government of Venezuela and of the Creole Petroleum Corporation.

[The characterstics of the research area are in brief as follows: Rancho Grande is located in north-central Venezuela (10° 21′ N. Lat., 67° 41′ W. Long.), 80 kilometers west of Caracas, at an elevation of 1,100 meters in the undisturbed montane rain forest which covers this part of the Caribbean range of the Andes. The migration flyway of Portachuelo Pass, which is also the water-shed between the Caribbean and Lake Valencia, is 200 meters from Rancho Grande. Adjacent ecological zones include seasonal forest, savanna, thorn woodland, cactus scrub, the fresh-water lake of Valencia and various marine littoral zones. The Rancho Grande area is generally subtropical, being uniformly cool and damp throughout the year because of the prevalence of the mountain cloud cap. The dry season extends from January into April. The average humidity during the expeditions, including parts of both wet and dry seasons, was 92.4%; the average temperature during the same period was 18° C.; the average annual rainfall over a five-year period was 174 cm. The flora is marked by an abundance of mosses, ferns and epiphytes of many kinds, as well as a few gigantic trees. For further details see Beebe & Crane, *Zoologica*, Vol. 32, No. 5, 1947. Unless otherwise stated, the specimens discussed in the present paper were taken in the montane cloud forest zone, within a radius of one kilometer of Rancho Grande.

[For an account of Portachuelo Pass, together with a general introduction to the groups of migrating insects and migrating factors, see "Insect Migration at Rancho Grande," by William Beebe, *Zoologica*, 1949, Vol. 34, No. 12, pp. 107-110. Papers dealing with specific groups are as follows; Papilionidae (Vol. 34, No. 14, pp. 119-126); Danaidae, Ithomiidae, Acraeidae and Heliconidae (Vol. 35, No. 3, pp. 57-68); Pieridae (Vol. 35, No. 16, pp. 189-196].

[1] Contribution No. 891, Department of Tropical Research, New York Zoological Society.

MIGRATION OF NYMPHALIDAE (NYMPHALINAE).

The nymphalid migrants of Portachuelo Pass, Venezuela, comprise a varied and colorful group of 55 species. Of three species only two specimens were taken, while in the case of six others, only a single individual was observed or captured. On the other hand, *Eunica monima* and *Marpesia chiron* excelled all other species of Lepidoptera of whatever family in sheer abundance. They thus live up to a similar reputation in many records of migration in literature.

Euptoieta hegesia hegesia (Cramer).

Field Name: Orange Fritillary.

Species Range: Southern United States to Argentina.

Subspecies Range: Southern United States to middle South America.

Field Characters: This species recalls in general the heliconid *Agraulis vanillae*. Although it has such a continental distribution and is common in many localities, we took but a single migrant.

Record: 1945—May 28 (1 taken, 45467).

Phyciodes carme carme (Doubl. & Hew.).

Field Name: Orange-banded Spotted Nymphalid.

Species Range: Colombia and Venezuela.

Subspecies Range: Venezuela.

Field Characters: Medium, black, with wide orange hindwing band, large forewing spots.

Number: Total, 9. Taken, 5.

Sex: Both sexes taken.

Date: April 27 to July 16.

Record: 1945—July 16 (1 taken). 1948—April 27 (1 taken, 48403; 2 seen); May 6 (1, 48494); June 6 (1); July 2 (1 taken, 2 seen).

Phyciodes clio estebana Hall.

Field Name: Eight-spotted Black-and-white.

Species Range: Mexico to Bolivia.

Subspecies Range: Venezuela.

Field Characters: Four large white spots on forewing, white band on hindwing.
Number: A rare species. Total, 12. Taken, 3.
Date: July 3 to 21.
Record: 1948—July 3 (1 taken, 4 seen), 10 (1), 21 (1 taken, 481274; 6 seen).

Phyciodes drusilla drusilla (Felder).
Field Name: Small Buff-freckled Black.
Species Range: Mexico to Bolivia.
Subspecies Range: Panama, Colombia and Venezuela.
Field Characters: An inconspicuous buff-freckled butterfly. None seen except those which were taken.
Number: Taken, 8.
Sex: Both sexes taken.
Date: April 27 to July 18.
Record: 1945—June 2 (1), 13 (1). 1946—April 27 (1). 1948—April 30 (1, 481453); July 3 (1), 15 (2), 18 (1).

Phyciodes leucodesma (Felder).
Field Name: One-spotted Black-and-white.
Species Range: Nicaragua to Colombia, Venezuela and Trinidad.
Field Characters: Easily confused in the field with *Dynamine theseus*.
Number: This wide-spread species is common in many places, but only a single migrant was seen or collected.
Record: 1948—July 15 (1 taken, 481550).

Phyciodes liriope anieta (Hew.).
Field Name: Small Orange-buff.
Species Range: Mexico to Argentina.
Subspecies Range: Guatemala to Bolivia and Venezuela.
Field Characters: A small orange-buff insect, with dark border and forewing bar.
Number: Total, 172. Taken, 26.
Sex: Both sexes taken.
Date: March 15 to September 8.
Record: 1945—March 23 (1), 28 (1); April 25 (1); June 20 (1); July 15 (4). 1946—September 8 (1, 461170; 82 plus seen). 1948—March 15 (2 taken, 14 resting on leaves), 15 (1, 48325; fresh brood, 20 plus passing or mating); April 27 (2, 48401; 24 seen, 16 mating), 29 (1); May 21 (1), 25 (2, 48589); June 6 (1); July 3 (1), 13 (1), 16 (1), 23 (2). On July 13, 23 and 24 individuals were taken at Km. 15, a short distance south of the pass.

Chlosyne janais hyperia (Fabr.).
Field Name: White-dotted Black.
Species Range: Texas to Colombia.
Subspecies Range: Mexico to Venezuela.
Field Characters: Small black nymphalid, with crescent of white dots or spots on forewing. Easily identified on wing.
Number: Total, 227. Taken, 1. Curiously limited as to date; abundant on two days, otherwise not observed.
Date: July 15 and 26.
Record: 1948—July 15 (1, 481547; 16 seen), 26 (210 counted passing through Pass in loose flock, 11 to 11:30 A.M.).

Chlosyne lacinia saundersii (Doubl. & Hew.).
Field Name: Small Buff-and-orange-banded Black.
Species Range: United States to Bolivia and Venezuela.
Subspecies Range: Colombia and Venezuela.
Field Characters: Slow flight makes identification easy. Somewhat resembles the narrow-winged *Phyciodes carme*.
Number: Total, 328. Taken, 9.
Date: March 16 to July 24.
Record: 1945—March 16 (1, 45465); July 20 (1, 45466). 1948—June 16 (1 taken, 10 worn ones seen); July 17 to 24 common on migration, about 300 seen), 24 (6 taken, 9 seen).

Chlosyne narva (Fabr.).
Field Name: Small Narrow-winged Yellow-spotted Nymphalid.
Species Range: Mexico to Peru and Venezuela.
Field Characters: The narrow wings, the white distal dots and the proximal yellow area characterize this species and make identification easy.
Number: Total, 264. Taken, 34. Two good-sized flocks.
Date: April 30 to July 24.
Record: 1945—June 12 (1), 20 (1). 1946—June 26 (1). 1948—April 30 (1, 48461; 3 seen); May 9 (2); June 15 (1), 30 (2 taken, 55 seen); July 2 (2), 10 (4 seen), 13 (1 at pass, 1 at Km. 15), 14 (2), 15 (3 at pass, 1 at Km. 15), 16 (1 taken, 79 seen), 17 (1), 23 (3 at pass, 3 at Km. 15), 14 (2 at pass, 61 seen, 3 at Km. 15).

Vanessa virginiensis braziliensis (Moore).
Field Name: Dwarf Painted Beauty.
Species Range: Widely distributed in North and South America.
Subspecies Range: Colombia and Venezuela to Peru and Brazil.
Field Characters: Under a new name this is our northern Painted Beauty, *Vanessa hunteri*, slightly smaller and forming the tropical subspecies. It is a close relative of *Vanessa cardui*, one of the most famous of the world's migrants.
Number: Total, 70. Taken, 3. Singly, except for one large flock. One taken migrating through the neighboring pass of Choroni.
Date: April 5 to June 16.
Record: 1945—April 5 (1); June 16 (1 at Choroni). 1948—May 21 (1, 48541; 76 on leaves or fighting against wind).

Junonia evarete zonalis Felder.
Field Name: Tropical Buckeye.
Species Range: United States to Argentina.
Subspecies Range: Mexico to Colombia, Venezuela and Trinidad.
Field Characters: In general slightly darker than our familiar northern *Junonia coenia*.
Number: Total, 18. Taken, 2.

Date: April 10 to July 17.
Record: 1945—(8 seen). 1948—July 3 (1 taken, 8 seen), 17 (1).

Hypanartia dione (Latr.).

Field Name: Dark-striped Brown.
Species Range: Guatemala to northern South America and Brazil.
Field Characters: A dull, tailed medium-sized insect, brown with several dark bands extending across all four wings.
Number: Total, 7. Taken, 2.
Record: 1948—July 9 (1 taken, 5 seen, all worn), 24 (1, 481545).

Hypanartia lethe (Fabr.).

Field Name: Black-and-orange Barred.
Species Range: Texas to south Brazil.
Field Characters: Unique in barred black-and-orange forewing, and almost solid orange hindwing.
Number: Total, 6. Taken, 6.
Date: April 7 to July 15.
Record: 1946—April 7 (1); July 8 (1, 461025). 1948—April 29 (1); May 21 (1), 26 (1); July 15 (1, Km. 15).

Anartia amathea amathea (Linn.).

Field Name: Red-banded White-starred Anartia.
Species Range: Central America to Brazil.
Subspecies Range: Colombia, Venezuela, Trinidad and the Guianas.
Field Characters: Broad central red band across both wings; rest white-dotted black.
Number: Total, 119. Taken, 17. Usually singly. Two flocks of 12 and 86 respectively.
Date: May 8 to September 7.
Record: 1945—May 24 (1); July 15 (2). 1946—May 29 (10); July 3 (1, 46725; 12 seen); September 7 (2 taken, 86 seen). 1948—May 8 (1); July 3 (1), 9 (1 taken at pass, at Km. 30, 4 seen), 15 (2), 16 (2), 21 (2).

Anartia jatrophae jatrophae (Linn.).

Field Name: Pearly-white Anartia.
Species Range: West Indies, northern South America to Brazil.
Subspecies Range: Lesser Antilles and South America.
Field Characters: The pearly-white ground color could only be confused with *Ageronia februa,* and that hardly.
Number: Occasionally seen, not counted. Taken, 1.
Date: May 28 to July 3.
Record: 1945—May 28 (1, 45457). Seen in 1948 several times in May, June and July, but none taken.

Eunica caralis indigophana Felder.

Field Name: Medium Brown-black Nymphalid.
Species Range: Colombia, Venezuela and Peru.
Subspecies Range: Venezuela.
Field Characters: Brownish-black, with faintly lighter forewing outer band. May be confused with upper side of *Marpesia coresia.*
Number: Total, 4. Taken, 1.
Record: 1948—July 18 (1, 481246; 3 seen).

Eunica monima (Cramer).

Field Name: Small Ten-spot Brown.
Species Range: Mexico to Venezuela and Brazil.
Field Characters: Dark brown with five white spots in the anterior half of the forewings.
Number: By far the most numerous migrant passing through Portachuelo Pass. There is no need to reproduce all the records of this small, inconspicuous nymphalid through our days of migration observation in 1945, 1946 and 1948. The days on which none were recorded were the memorable ones. In July and August of the first year, before systematic noting of migrants had begun, I find mention of thousands of the small ten-spot, fluttering through the pass or collecting on the lee side waiting for a strong wind to die down. On August 7 with a sprinkling of other species was a host of the smaller butterflies, crowded together in mid-air, close to earth and as high up as we could see.

As one example of many similar occurrences, on May 4, 1946, I found a dense flock of the ten-spots in full migration. Like minute motes they converged on the Pass and with one sweep of the net I took seven, five of which were tattered and torn, two freshly emerged. We climbed the mound close to the Pass and two of us, facing in opposite directions, at eye level, averaged thirteen hundred butterflies of this species in several counts of four minutes each. At intervals throughout an hour and a half, this insect content remained fairly constant and when we left we knew that at the very least 286,000 ten-spots has passed close to us. An hour later the insects were still going full strength. With 20-power binoculars I followed the swarm a full half mile upwards and at vanishing point they appeared as numerous as close to the ground.

Three weeks later, on May 24, there was a resurgent migration of freshly emerged insects, in numbers far exceeding the earlier flocking. Day after day this continued, passing beyond any definite human calculation, the total attaining astronomical proportions.

In 1948 the ten-spots were to be estimated only in tens of thousands and on only a few days. Usually the daily count varied from 8 or 12 to 800 or 1,000. As a whole it was decidedly less than in the other two years, but taken alone, the numbers were impressive. Days of unusual abundance were May 26 (worn and tattered), June 27 and 28 (freshly emerged for the most part), and July 21.

Eunica near **viola** Bates.

Field Name: Large White-banded Brown.
Species Range: (*viola*) Central South America.
Field Characters: The white oblique band across the forewing of this brownish-black

insect makes its conspicuous on the wing. It appears to be closest to the female *viola*, but above is indistinguishable from the female *alcmena*.

Number: Total, 18. Taken, 2.
Date: May 9 to July 14.
Record: 1948—May 9 (1 ♀, 48515); July 14 (1 ♀, 481172; 16 seen in close flock).

Dynamine getae (Godman & Salvin).

Field Name: Shining-green Ten-spot.
Species Range: Venezuela, Peru and Bolivia.
Field Characters: The five large white spots on each forewing, and the iridescent green sheen of the hindwing are characters of the male. The female is indistinguishable in life from *Phyciodes clio*.
Number: Total, 6. Taken, 3.
Date: June 22 to July 21.
Sex: Both sexes taken.
Record: 1948—June 22 (1♂, 48878); July 10 (1♀), 21 (1♂, 481272; 3 seen).

Dynamine glauce Bates.

Field Name: Green-sheen Nymphalid (male).
Species Range: Central America to Bolivia and the Amazon.
Field Characters: Male is covered with a green sheen with dark border. Female like the same sex in the preceding species.
Number: Total, 26. Taken, 4. The one flock of 22 was close at hand, drifting along in a compact group, and two were taken.
Sex: Both taken.
Date: June 6 to July 20.
Record: 1948—June 6 (1♀, 481554), 17 (1♂ and 1♀, 48831; 22 seen); July 20 (1♂, 481553).

Dynamine mylitta (Cramer).

Field Name: Black-spot Green-sheen Nymphalid.
Species Range: Widely distributed in neotropics.
Field Characters: Male, shimmering green with central black spot in forewing, and irregular hindwing border. Female without green, and with seven large forewing spots, and three hindwing bands.
Number: Total, 52. Taken, 18.
Sex: Both taken.
Date: May 7 to July 26.
Record: 1945—June 20 (1♂, 45330, Km. 15); 21 (1♂). 1946—May 7 (1♀, 46434; 3 seen), 28 (1♀). 1948—June 6 (1♀, 48740), 7 (3), 9 (1), 21 (1♀, 48879; 6 seen), 22 (1♂, 48880; 17 seen); July 8 (8 seen), 15 (2), 16 (1), 21 (1), 23 (1, Km. 15), 25 (1), 26 (1, 481391).

Dynamine theseus (Felder).

Field Name: Broad-bordered White.
Species Range: Mexico to Colombia and Venezuela.
Field Characters: Large white central area on both wings reduces black to a very wide border, on forewing enclosing two dots and one spot.
Number: Total, 5. Taken, 5.
Date: May 15 to September 7.
Record: 1946—September 7 (1). 1948—May 15 (2); July 15 (1), 16 (1).

Callicore marchalii (Guérin).

Field Name: Red-underwing Eighty-nine
Species Range: Colombia and Venezuela.
Field Characters: Black with glittering green band on forewing. Forewing below mostly scarlet.
Number: Total, 169. Taken, 5.
Date: March 22 to September 1.
Record: 1946—March 22 (1); May 15 (1) 25 (18 fighting against wind); September (counted 80 out of many more). 1948—July 15 (2, 481552; all worn), 20 (1 taken, seen), 24 (14 at Km. 19, 26 at Km. 20, 1 at Pass), 25 (11 at Pass).

Callicore metiscus Doubl. & Hew.

Field Name: Black-underwing Eighty-nine.
Species Range: Venezuela.
Field Characters: Black above with glittering green forewing band. Forewing below mostly black.
Number: Total, 103. Taken, 15.
Date: April 30 to July 29.
Record: 1945—June 4 (1), 13 (1), 17 (2) 21 (1), 28 (1); July 18 (1). 1946—July (1). 1948—April 30 (12 passed); May 2 (1, 481544); July 16 (1), 20 (1), 21 (2) 23 (1, Km. 15), 25 (1, 481551), 29 (76 seen).

Perisama humboldtii humboldtii (Guérin).

Field Name: False Buff-underwing Eighty-nine.
Species Range: Colombia, Venezuela, Peru and Ecuador.
Field Characters: Green band on both wings; below hindwing buff.
Number: Taken, 2.
Date: April 27 to June 5.
Record: 1948—April 27 (1, 48402, worn) June 5 (1, 48739).

Perisama xenoclea Felder.

Field Name: Gray-underwing Eighty-nine.
Species Range: Venezuela.
Field Characters: Bronze green band on all wings. Hindwing below pale gray.
Number: Only one taken.
Record: 1948—May 9 (1, 48577).

Catagrama pitheas (Latr.).

Field Name: Scarlet-and-black Eighty-nine.
Species Range: Panama to Venezuela.
Field Characters: The wide, oblique scarlet splashes on the black upperside, and two black ocelli on the pink hindwing underside are unmistakable characters.
Number: Total, 174. Taken, 6. Two flocks of 14 and 154 seen.
Date: June 21 to July 30.
Record: 1945—June 21 (1); July 3 (2) 1946—July 30 (1, 46870; 154 counted). 194

-July 13 (1, 481163; 14 seen), 19 (1, ı1255; 2 seen south of Pass).

ɫamadryas amphinome amphinome (Linn.).

Field Name: Red-underwing Blue Agerıia.

Species Range: Mexico to Bolivia and razil.

Subspecies Range: North and middle outh America.

Field Characters: Blue-freckled Ageronia ith red on under hindwings.

Number: Total, 52. Taken, 3.

Date: June 6 to August 8.

Record: 1945—June 22 (1 taken, 6 seen). 948—June 6 (23 seen, many momentarily esting on tree trunks), 10 (17 seen), 28 1, 481454); July 8 (3 seen), 22 (1).

Hamadryas februa februa (Hübner).

Field Name: White-underwing Gray geronia.

Species Range: Mexico to south Brazil, lso West Indies.

Subspecies Range: Panama, Colombia, enezuela to north Brazil.

Field Characters: Freckled gray above. nder hindwings chiefly white.

Number: Total, 70. Taken, 13.

Date: April 30 to July 21.

Record: 1946—May 28 (1), 29 (6 seen); une 19 (1). 1948—April 30 (8 seen); May (1, 48493); June 6 (5); July 5 (1 taken, 5 seen), 6 (22 seen), 13 (1, Km. 15; 1 at ass), 15 (1, Km. 14), 21 (3 at Pass feedıg on rotten mangos).

Hamadryas fornax fornax (Hübner).

Field Name: Orange-underwing Gray geronia.

Species Range: Texas to south Brazil.

Subspecies Range: Venezuela to south razil.

Field Characters: Freckled gray above ith white forewing spots.

Number: Total, 23. Taken, 4.

Date: April 9 to July 5.

Record: 1945—April 9 (1); July 3 (1), (1). 1948—May 23 (4 seen); July 3 (1, 81052; 9 seen), 5 (6 seen).

Didonis biblis biblis (Fabr.).

Field Name: Red-hind-edge Black.

Species Range: Mexico to Paraguay.

Subspecies Range: Colombia to central razil.

Field Characters: Black, with a wide brilant red edge to the hind wings.

Number: Total, 72. Taken, 16.

Date: May 28 to July 30.

Record: 1946—May 28 (9), 29 (1); July 0 (2, 46870; 54 seen). 1948—June 6 (1, 8742), 17 (1); July 12 (2 seen), 21 (2).

Cystineura bogotana Felder.

Field Name: Pale Gold-spotted Nymhalid.

Species Range: Colombia and Venezuela.

Field Characters: A pale species with gold nd white bands and rows of spots.

Number: Total, 10. Taken, 6.

Date: May 23 to July 15.

Record: 1948—May 23 (1, 48577; 4 fluttering past), 26 (1), 29 (1); June 6 (2); July 15 (1, Km. 15).

Pseudonica flavilla sylvestris (Bates).

Field Name: Small Black-tipped Orange.

Species Range: Central America to Peru and south Brazil.

Subspecies Range: Colombia to the Amazon.

Field Characters: Solid orange with large forewing tips black.

Number: Total, 21. Taken, 4.

Date: June 17 to July 26.

Record: 1948—June 17 (2, 48830; 17 seen); July 21 (1, 481273), 26 (1).

Pyrrhogyra edocla edocla Doubl. & Hew.

Field Name: Two-spotted Green-bar.

Species Range: Central America to Peru and Brazil.

Subspecies Range: Colombia and Venezuela.

Field Characters: Black with two large green spots and a wide long green bar.

Number: Only two taken, together.

Record: 1948—May 23 (2, 48544, 48546).

Pyrrhogyra neaerea juani Staud.

Field Name: Large Split-green-bar.

Species Range: Mexico to Paraguay.

Subspecies Range: Colombia and Venezuela.

Field Characters: Large Black, with broad, slightly interrupted median pale green band.

Number: Total, 13. Taken, 13.

Date: May 28 to July 15.

Record: 1945—July 15 (1). 1946—May 28 (2). 1948—May 28 (1); June 6 (3); July 3 (3), 14 (1, 481510), 15 (3).

Marpesia chiron chiron (Fabr.).

Field Name: Pale-banded Longtail.

Species Range: Mexico and the Antilles south over tropical South America.

Subspecies Range: Tropical South America.

Field Characters: Good-sized, with one long and a second short tail. Brown, crossed by several pale bands. Apical spots.

Number: Second only to the vast numbers of *Eunica monima*, this is the second most abundant migrant through the pass. Total, tens of thousands. Taken, upwards of one hundred.

Throughout the three years of observation at Portachuelo Pass no week passed without our seeing *Marpesia chiron*. Sometimes for days in succession, they would appear, singly or in small companies, or as on May 6, 1945, or July 18, 1946, or April 14, 1948. From one hundred to many thousands passed through the sixty-foot-wide gap in the mountains. They were inconspicuous in color, but their considerable size and long tails made it easy to identify them as they

fluttered rather slowly past. New broods were apparent now and then, but showed no regularity in time of arrival. Frequently this species was seen in pure culture flocks, set off sharply by themselves. When mingled with others it was almost invariably with the still more numerous *Eunica monima*. We traced both of these abundant species several kilometers north and south of the Pass but could never discover their more ultimate origins or destinations.

Marpesia coresia (Godart).

Field Name: White-and-brown Underwing.
Species Range: Texas south to Peru and Brazil.
Field Characters: Upperside dull black with indistinct paler border. Below sharply divided into proximal half white, distal half brown. Easily distinguished in flight, but not when wings are held flat in repose.
Number: Total, 435. Taken, 7.
Date: May 1 to September 5.
Record: 1946—September 5 (1 taken, 127 counted high and fast). 1948—May 1 (1, 48473); June 22 (1); July 3 (1 taken, 3 seen), 5 (1, Km. 18), 10 (1 taken, Km. 31, 2 at pass, 300 seen).

Marpesia marcella (Felder).

Field Name: Violet-and-orange Longtail.
Species Range: Central and northern South America.
Field Characters: Large longtail, anteriorly chiefly orange, male hindwing violet, female brown.
Number: Total, 264. Taken, 10. One large flock of 225.
Sex: Both taken.
Date: April 29 to September 7.
Record: 1946—July 8 (1, 46753; 29 seen); September 7 (1, 461149; 225 plus seen). 1948—April 24 (1♂, 48379), 29 (1♀, 481455); May 1 (2), 23 (1); June 6 (1♀).

Marpesia peleus (Sulzer).

Field Name: Black-striped Orange Longtail.
Species Range: Mexico to Brazil.
Field Characters: Large orange longtail, crossed by black bands.
Number: Total, 16. Taken, 4.
Record: 1946—July 8 (2 taken, 12 passed in small flock). 1948—June 6 (1, 48741); July 23 (1).

Victorina epaphus (Latr.).

Field Name: Large White-striped Orange-and-black.
Species Range: Mexico to Peru and Brazil.
Field Characters: Forewing distally orange, proximally black, separated by a white bar. Hindwing black with the white bar continued across. Very easy to detect in life.
Number: One of the most abundant migrants. Total counted, 426, plus hundreds uncounted. Taken, 33.
Date: April 29 to July 26.
Record: 1945—June 21 (1); July 16 (seen). 1948—April 29 (3, 48446; 2 seen) May 21 (2 taken, 8 seen); June 28 (1 taken 28 high), 29 (18 seen), 30 (6 high); July (2, 481030; 5 at Km. 27, 6 seen), 4 (3 at pass 2 at Km. 18, 32 seen), 5 (13 seen), 6 (taken, 22 seen), 14 (6 seen), 15 (2 taken 23 seen), 16 (3 taken, 42 seen), 17 (76 seen) 20 (2), 21 (2 taken, 45 seen, 24 (1 taken a pass, 6 seen at Km. 19), 26 (18 seen).

Victorina stelenes stelenes (Linn.).

Field Name: Green-spotted Leaf Nymphalid.
Species Range: Texas to Bolivia and south Brazil.
Subspecies Range: Northern South America to Ecuador, Guianas and Brazil.
Field Characters: Black, coarsely banded and spotted with pale green. Can be confused with the narrow-winged heliconid *Philaethria dido*.
Number: Total, 1,092. Taken, 19.
Date: March 15 to September 8.
Record: 1946—May 27 (13 seen), 28 (seen); July 23 (7, 46842), 28 (83 seen), 29 (16 seen); September 7 (large flock, about 600), 8 (250 plus, fast and erratic). 1948—March 15 (16 seen); April 1 (4 seen), 29 (2, 48444; 2 seen); May 4 (64 drifting slowly, some alighting), 23 (1, 48572), 24 (2 48574; 8 seen); July 3 (1 taken, 12 seen) 4 (1), 13 (1 taken, 12 high), 19 (2 at Pass 2 at Km. 15).

Adelpha boeotia boeotia (Felder).

Field Name: Small Orange-and-white-striped Brown.
Species Range: Central America to Bolivia and Brazil.
Subspecies Range: Colombia and Venezuela.
Field Characters: Small brown with mid-stripe, orange on forewings and white on hindwings.
Number: A single specimen taken.
Record: 1948—April 29 (1, 481451).

Adelpha celerio celerio (Butler).

Field Name: Red-spotted Blue-stripe.
Species Range: Mexico to Peru, Bolivia and Venezuela.
Subspecies Range: Guatemala to Colombia and Venezuela.
Field Characters: Dark brown with pale mid-stripe, breaking up on forewing into two pale spots and a large red spot.
Number: Only a single specimen taken.
Record: 1948—June 6 (1, 48748).

Adelpha irmina irmina (Doubl.).

Field Name: Buff-barred Brown.
Species Range: Peru, Bolivia and Venezuela.
Subspecies Range: Venezuela.
Field Characters: Dark brown with broad, oblique, buff band across mid-forewings.
Number: Total, 81. Taken, 10.
Date: February 27 to July 17.
Record: 1946—February 27 (1, 46106);

.pril 27 (1); June 13 (47 passed, fast erratic flight). 1948—April 28 (1, 48427; 3 een); May 24 (1), 26 (2); July 10 (1 taken, seen), 11 (1 taken, 8 seen), 12 (1, 481144), 7 (1, 481247).

Adelpha lara lara Hew.

Field Name: Scarlet-banded Black.
Species Range: Colombia, Venezuela and olivia.
Subspecies Range: Venezuela.
Field Characters: Black, with broad scaret band obliquely across forewings, hence a lose mimic of the narrower-winged *Heli-onius melpomene*. Beneath, the venation is narked with black.
Number: Total, 20. Taken, 4.
Date: April 30 to July 3.
Record: 1948—April 30 (2, 48460; 12 een); June 28 (1 taken, associated with 3 *nelpomene* models); July 3 (1, 481025; 4 een).

Adelpha olynthia inachia Fruh.

Field Name: Small Brown Nymphalid.
Species Range: Colombia and Venezuela o Ecuador and Peru.
Subspecies Range: Venezuela.
Field Characters: The dullest of nymphalid migrants; bronze-brown above and ighter brown below.
Number: Total, 13. Taken, 7.
Date: April 29 to July 15.
Record: 1945—July (1). 1948—April 29 2, 481449); May 9 (2); June 6 (1); July 4 (1, 481511; 6 seen).

Chlorippe cyane cyane (Latr.).

Field Name: Small Green - hindwing Brown.
Species Range: Colombia to Peru.
Subspecies Range: Colombia and Venezuela.
Field Characters: Black, with the whole center of the hindwing iridescent green. In general appearance a dwarf *Prepona chromus*.
Number: Two only taken.
Record: 1948—April 24 (1); July 18 (1).

Historis acheronta acheronta (Fabr.).

Field Name: Large, 12-dotted Orange-flash Black.
Species Range: Mexico and West Indies to south Brazil.
Subspecies Range: Tropical South America.
Field Characters: Forewing black with six white dots, and proximal shades of orange. Hindwing dark brownish.
Number: Total, 55. Taken, 3.
Date: May 30 to August 8.
Record: 1946—May 30 (1 taken, 24 seen). 1948—July 8 (1, 481117), 14 (29 passing and resting); August 8 (1).

Smyrna blomfildia blomfildia (Fabr.).

Field Name: Large, 6-dotted Gold-and-black Nymphalid.
Species Range: Widely distributed in American tropics.
Subspecies Range: Tropical South America.
Field Characters: Rich golden-orange, except for black distal half of forewings, enclosing 3 white dots.
Number: Total, 46. Taken, 5.
Date: May 18 to July 27.
Record: 1948—May 18 (1 taken, 27 seen); July 13 (2 taken, 5 seen), 16 (1, 481206; 1 seen), 27 (1, 481400; 8 seen).

Prepona antimache andicola (Fruh.).

Field Name: Large Blue-barred Prepona.
Species Range: Central America to Peru and the Amazons.
Subspecies Range: Venezuela, to Ecuador and Peru.
Field Characters: Large, black, with a wide, central, iridescent blue band across all four wings.
Number: One specimen taken. Uncertain whether at the Pass or a short distance to the south.
Record: 1946—August 7 (1).

Prepona chromus chiliarches Fruh.

Field Name: Large Green - hindwing Brown.
Species Range: Colombia, Venezuela, Ecuador and Peru.
Subspecies Range: Venezuela.
Field Characters: Blackish-brown with large iridescent green spot in central hindwing.
Number: Total, 13. Taken, 4.
Date: May 4 to July 11.
Record: 1945—May 4 (1 taken, 2 seen); July 3 (1). 1948—May 5 (1 taken, 1 seen); July 11 (1 taken, 6 seen).

Prepona demophon centralis Fruh.

Field Name: Large Green-bar Black.
Species Range: Mexico to Guianas, Brazil and Paraguay.
Subspecies Range: Honduras to Venezuela.
Field Characters: Black, with wide iridescent green bar across center of all wings.
Number: Total, 82. Taken, 5.
Date: April 29 to July 28.
Record: 1945—July 6 (1 taken, 3 seen at rotten mangos, 6 migrating). 1946—May 28 (3 migrants), 29 (1 taken, 3 seen), 30 (8 seen); July 28 (1 taken, 46 seen). 1948—April 29 (1, 48447; 6 seen); May 15 (1 taken, 2 seen).

Anaea pseudiphis Staud.

Field Name: Blue-spotted Nymphalid.
Species Range: Colombia and Venezuela.
Field Characters: Black, shot basally with iridescent blue, and with forewings spotted with shining blue.
Number: Total, 24. Taken, 2.
Date: April 23 to June 4.
Record: 1948—April 23 (1 taken, 12 seen, all new and fresh); May 9 (3 seen); June 4 (1 taken, 7 seen).

Anaea xenocles (Westw.).

Field Name: Large Black-framed Green Nymphalid.

Species Range: Mexico to Argentina.

Field Characters: Wings black with basal half of all glowing green.

Number: Only two taken.

Record: 1948—May 24 (1, 48586); July 23 (1, 481549).

Protogonius hippona trinitatis Rober.

Field Name: Large Ithomiid-mimicking Nymphalid.

Species Range: Mexico to Peru and Brazil.

Subspecies Range: Venezuela and Trinidad.

Field Characters: Indistinguishable on the wing from the ithomiid *Olyris crathis*. Well developed tails.

Number: Total, 30. Taken, 3.

Record: 1946—September 8 (3, 461171; 27 seen, passing slowly. The three captured from center of flock).

MIGRATION OF BRASSOLIDAE AND MORPHIDAE.

These two families number, between them, only five species of migrants going south through Portachuelo Pass. They are the largest and among the most brilliant of all butterflies. As migrants, however, they are almost the rarest and the most casual. They were more common flying along the Rancho Grande road and the surrounding jungle trails than through the Pass itself.

BRASSOLIDAE.

Caligo atreus ajax (Linn.).

Field Name: White-and-gold-banded Caligo.

Species Range: Southern Mexico to Venezuela and Peru.

Subspecies Range: Venezuela.

Field Characters: Sub-terminal creamy white band along all four underwings. Above white band on fore, gold on hindwings.

Record: 2 migrants taken, five others flying and taken along trails in jungle. 1946—April 13 (1), 19 (1).

Caligo eurilochus caesia Stichel.

Field Name: Violet-winged Owl Butterfly.

Species Range: Honduras to Bolivia and south Brazil.

Subspecies Range: Venezuela.

Field Characters: The largest migrant, spreading more than six inches. Dark brown above, shot with a violet sheen.

Number: A rare migrant. Total, 16. Taken, 4. More seen in jungle trails and along road than passing south through Pass.

Record: 1945—May 16 (1). 1948—July 15 (1, 481498), 21 (1, 481335), 29 (1, 481435; 3 seen).

Caligo teucer teucer (Linn.).

Field Name: Black-and-gold Owl Butterfly.

Species Range: Central America to northern Brazil and western Peru.

Subspecies Range: Guianas, northern Brazil and Peru.

Field Characters: Forewing chiefly golden-buff, rest of all wings blackish.

Number: A single specimen taken.

Record: 1946—July 20 (1).

Opsiphanes cassina merianae Stichel.

Field Name: Orange-banded Brassolid.

Species Range: Mexico to south Brazil and Bolivia.

Subspecies Range: Northern South America.

Field Characters: Brown above, with a wide, encircling orange band on all four wings.

Number: Two seen and taken.

Record: 1945—July 15 (1). 1948—July 18 (1, 481247).

MORPHIDAE.

Morpho peleides corydon Guénée.

Field Name: Blue Morpho.

Species Range: Mexico to Ecuador and south Brazil.

Subspecies Range: Venezuela.

Field Characters: The familiar iridescent blue bird-wing Morpho.

Number: An uncommon and casual migrant. A few seen and taken in Pass. Others along road and on jungle trails.

Record: 1945—April 18 (1). Two others on later dates. 1948—Six were seen and several taken at various times.

MIGRATION OF LIBYTHEIDAE.

In spite of a reputation elsewhere for migration, this small family of the Snout Butterflies is represented in the Portachuelo Pass migrants by only eight specimens of a single species.

Libytheana carimenta carimenta Cramer.

Field Name: Orange-and-white-spotted Snout Butterfly.

Species Range: Southern United States to south Brazil.

Subspecies Range: Tropical South America.

Field Characters: Small brown, six apical, white, forewing spots; three large orange spots elsewhere.

Number: Total seen and taken, 8.

Record: 1948—June 6 (4, 48732); July 12 (1, 481165), 15 (1), 17 (1), 23 (1).

SATYRIDAE.

Hundreds of satyrids were seen passing from north to south through Portachuelo Pass. The few captured resolved into 14 species. All but two of these were indistinguishable on the wing, and even in the hand it was not easy in the field to separate them. The two which exhibit distinguishing white markings are *Oressionoma typhla* and *Euptychia hesione*. The other 12 are of varying shades of brown, differing somewhat in size and by the absence or the inconspicuous presence of small ocelli. More than in any

other family the majority of these satyrids were worn, rubbed and torn. Among these are the most abundant, resident, trail butterflies.

I have dispensed with field names and characters.

Taygetis andromeda, form **andromeda** (Cramer).

Species Range: Mexico to Paraguay.
Number: Taken, 6.
Record: 1945—March 6 (1), 24 (1); July 11 (1). 1948—March 1 (1, 48309); May 8 (2, 48507).

Euptychia calixta Butler.

Species Range: Colombia.
Number: Taken, 1.
Record: 1948—June 6 (1).

Euptychia hermes fallax (Felder).

Species Range: New Jersey to south Brazil.
Subspecies Range: Venezuela to northern Brazil.
Number: Taken, 25.
Record: 1945—March 31 (1); April 11 (3), 19 (4), 26 (2), 28 (3). May 4 (1); August 9 (1). 1948—April 27 (1, 48400); May 18 (1), 25 (1); June 21 (1), 30 (1); July 2 (2), 15 (1), 17 (1), 20 (1).

Euptychia hesione, form **hesione** Sulzer.

Species Range: Mexico to south Brazil.
Number: Taken, 5.
Record: 1948—July 10 (1), 15 (2), 21 (1), 23 (1).

Euptychia innocentia (Felder).

Species Range: Venezuela.
Number: Taken, 1.
Record: 1948—July 14 (1, 481164).

Euptychia labe, form **confusa** Staud.

Species Range: Mexico to Ecuador.
Number: Taken, 1.
Record: 1948—May 24 (1).

Euptychia near **necys** Godart.

Species Range: Colombia, Ecuador, Bolivia and Brazil.
Number: Taken, 2.
Record: 1945—April 23 (1); May 20 (1).

Euptychia phares (Godart), form **phares** (Godart).

Species Range: Venezuela to Argentina.
Number: Taken, 1.
Record: 1948—July 15 (1).

Euptychia renata peloria (Felder).

Species Range: Central America, Colombia, Venezuela, Guianas and Brazil.
Number: Taken, 2.
Record: 1945—April 26 (1), 28 (1).

Euptychia saturnis Butler.

Species Range: Widely distributed in South America.
Number: Taken, 4.
Record: 1945—April 8 (2), 22 (1), 26 (1).

Euptychia terrestris Butler.

Species Range: Amazons and Surinam.
Number: Taken, 1.
Record: 1948—June 7 (1).

Oressinome typhla typhla Westw. & Hew.

Species Range: Costa Rica south to Colombia, Venezuela, Ecuador, Peru and Bolivia.
Subspecies Range: Same except Bolivia.
Number: Taken, 17.
Record: 1945—March 25 (1), 31 (1); April 11 (1), 18 (1), 22 (2), 26 (1), 28 (1); May 4 (1); June 3 (1). 1946—August 8 (1). 1948—June 7 (1); July 5 (1, 481031), 15 (3), 26 (1).

Pedaliodes japhleta (Butler).

Species Range: Venezuela.
Number: Taken, 1.
Record: 1946—April 29 (1).

Pedaliodes pisonia manis (Felder).

Species Range: Central America, Colombia, Venezuela, Peru, Ecuador and Bolivia.
Subspecies Range: Venezuela, Peru and Bolivia.
Number: Taken, 3.
Record: 1948—15 (1), 18 (1), 26 (1).

Migration of Riodinidae.

Twelve species of riodinids were recorded among the hosts of butterfly migrants through Portachuelo Pass. None were abundant although of *Hades noctula* 376 individuals were observed. Four species were represented by a single specimen each, and two others by two individuals. All the species were of small size and a majority were brilliant in pattern and coloring.

Euselasia russata (Godman & Salvin).

Field Name: Orange-banded Riodinid.
Species Range: Central America to Bolivia and south Brazil.
Field Characters: Small brown butterfly with a central, elongate orange band in all four wings.
Record: Only a single individual taken. 1948—May 24 (48516).

Hades noctula Westw. & Hew.

Field Name: Red-based Black.
Species Range: Mexico to northern Brazil.
Field Characters: Base of wings red. Rest black with white radiations on distal half of all wings.
Number: Total, 376. Taken, 52.
Notes: A common migrant, easily identified because of its fearlessness and slow flight. This is exceedingly weak and fluttering, the wing tissue easily torn and the scales very loose. When swooped at and missed it sinks to the ground, helpless to dodge. Never makes headway against wind of any strength.
Record: 1948—April 27 (1, 48399; 28

seen), 28 (1), 29 (1), 30 (6 seen); May 6 (1), 21 (4), 23 (3), 24 (3), 25 (6 taken, 61 seen), 26 (3 taken, 37 seen singly), 28 (1), 29 (2), 31 (5 taken, 38 seen); June 5 (34 seen), 6 (6), 7 (1), 17 (3 taken, 18 seen), 18 (1), 22 (1 taken, 12 seen), 23 (1), 27 (1), 30 (2 taken, 19 seen); July 3 (1 taken, 39 seen), 4 (2 taken, 11 seen), 6 (1 taken, 14 seen), 8 (1), 15 (1 taken, 31 seen), 16 (5 seen).

Mesosemia near **magete** Hew.

Field Name: White-barred Freckled Riodinid.
Species Range: Guianas.
Field Characters: Small, pale brown lined and freckled with darker; a broad, oblique, white forewing band; two central forewing ocelli with three white pupil dots. Closely resembles a satyrid.
Number: Total seen and taken, 2.
Record: 1945—May 1 (1). 1948—May 29 (1, 48667).

Lymnas iarbas iarbas (Fabr.).

Field Name: Gold-banded, Scarlet-dotted Black.
Species Range: Central America to Brazil.
Subspecies Range: Colombia, Ecuador, Venezuela and Trinidad.
Number: Total, 21. Taken, 8.
Record: 1948—June 6 (1, 48927; 8 seen); July 16 (4 taken, 5 seen), 20 (1), 21 (2).

Diorina dysonii, form **dysonii** Sndrs.

Field Name: Tailed Violet Riodinid.
Species Range: Northern South America.
Field Characters: A beautiful small riodinid, with long tails, a scarlet band at their base, two white bands across all wings.
Number: Total, 57. Taken, 2. Two singles and a dense flock of 55.
Record: 1945—June 2 (1). 1948—July 21 (1, 481269; 55 seen flying through pass).

Mesene margaretta (White).

Field Name: Striped-tip Orange.
Species Range: Central America to Colombia and Venezuela.
Field Characters: Small, orange, black-edged, the forewing black crossed by four white lines. Closely resembles certain geometrids and pyralids.
Number: Total, 6. Taken, 6.
Record: 1948—May 9 (1), 26 (2), 29 (1). June 6 (2, 481515).

Mesene silaris Godman & Salvin.

Field Name: Black-framed Pale Yellow Riodinid.
Species Range: Central America and northern South America.
Field Characters: Very small, broad brown frame around central pale yellow.
Record: A single specimen taken. 1948—May 25 (1, 48589).

Baeotis choroniensis Lichy.

Field Name: Small, Pale-barred Black.
Species Range: Venezuela.
Record: A single specimen taken. 1948—May 15 (1, 48524).

Argyrogramma holosticta (Godman & Salvin).

Field Name: Black-peppered Yellow Riodinid.
Species Range: Mexico to Peru and Trinidad.
Field Characters: Very small, pale yellow, thickly dotted with brown.
Number: Total, 25. Taken, 7.
Record: 1948—May 24 (1, 48585), 21 (1), 26 (2); June 6 (2 taken, 18 seen).

Sarota acantus (Cramer).

Field Name: Small Freckled-brown.
Species Range: Bolivia to the Guianas.
Field Characters: Very small, brown, indistinctly freckled with darker dots. Closely resembles a hesperid.
Number: Taken, 2.
Record: 1948—May 24 (1, 48586); August 2 (1).

Imelda kadenii (Felder).

Field Name: Black-bordered White Riodinid.
Species Range: Venezuela.
Field Characters: Complete black frame enclosing white. An orange and a white spot near tip of forewings. Closely resembles a nymphalid.
Number: Total, 65. Taken, 4.
Record: 1948—May 29 (1, 48668); June 30 (1 taken, 61 seen); July 2 (1, 491024), July 15 (1).

Theope eudocia acosma Stichel.

Field Name: Black-tipped Orange.
Species Range: Central America to Colombia and Guianas.
Subspecies Range: Colombia and Venezuela.
Field Characters: Small, a broad black tip to the forewings; the rest of the wings pale orange.
Record: Only a single individual taken. 1948—July 15 (1).

Migration of Lycaenidae.

Twenty species of Little Blues (Lycaenidae) were among the migrants through Portachuelo Pass. This is one of the most puzzling families of Lepidoptera even in a mounted collection, and infinitely more so on the wing or freshly caught in the field. Any attempt at reasonably clear Field Names or Field Characters is useless.

Two out of the 20 species (*Thecla azia* and *Leptotes cassius*) were migrating in tens of thousands, but most of these butterflies appeared singly or in small groups. Two specimens only were taken of seven species, and a single individual in the case of ten other species. If we could have redoubled our efforts we could doubtless have taken many more species. An interesting

association in small numbers is shown by 13 individuals taken on one day, June 6, 1948, which proved to represent ten species.

Thecla aepea Hew.

Species Range: Panama to Bolivia.
Record: 1948—May 25 (1); June 6 (1).

Thecla albata Felder.

Species Range: Panama, Colombia, Venezuela and Trinidad.
Record: 1948—July 21 (1).

Thecla amplia Hew.

Species Range: Guatemala to the Guianas.
Record: 1948—June 6 (1).

Thecla azia Hew.

Field Name: Dwarf Brown Lycaenid.
Species Range: Mexico to Brazil.
Number: Taken, 13. The following notes on abundance were made on several days of migrational peaks. May 26, 1948: Heavy flight of these small, brown lycaenids, ten to fifty every minute, increasing until 3 P.M. Jerky flight up and down, difficult insects to catch. June 24: Many hundreds. July 15: Many flocking with skippers. July 16: Thousands, from 8.30 A.M. to noon. July 21: Height of abundance, 1000's upon 1000's, steadily all day. Curious bobbing flight, flicking up and down. Two other larger species with them.
Record: 1948—May 26 (1); June 16 (1); July 8 (1), 13 (1), 15 (4), 16 (2), 20 (1), 21 (2).

Thecla cecrops beon (Cramer).

Species Range: Indiana to Brazil.
Record: 1948—July 15 (2), 16 (1), 21 (1).

Thecla celmus (Cramer).

Species Range: Mexico to south Brazil.
Record: 1948—June 6 (1, 48817).

Thecla cyphara Hew.

Species Range: Mexico to Venezuela.
Record: 1948—July 13 (1).

Thecla demonassa Hew.

Species Range: Mexico to Amazons.
Record: 1948—July 13 (1), 16 (1).

Thecla gizela Hew.

Species Range: Bolivia.
Record: 1948—June 6 (1), July 16 (1).

Thecla janthina janthina Hew.

Species Range: Guatemala to Brazil.
Record: 1948—July 26 (1).

Thecla mulucha Hew.

Species Range: Guatemala to Ecuador, Trinidad and Amazonia.
Record: 1948—July 11 (1, 481153).

Thecla nubes Druce.

Species Range: Panama, Venezuela and Trinidad.
Record: 1948—June 6 (1).

Thecla perisus Druce.

Species Range: Venezuela and Colombia.
Record: 1946—May 1 (1).

Thecla politus Druce.

Species Range: Guatemala to Trinidad and Amazonia.
Record: 1948—June 6 (1).

Thecla temesa Hew.

Species Range: Panama to Peru, Trinidad, Guianas and Amazonia.
Number: Taken, 2. Twice seen in large flocks. June 18, 1948, 100's seen. July 20, at least 500 seen flying with skippers.
Record: 1948—June 18 (1); July 20 (1).

Thecla theia Hew.

Field Name: Dwarf Morpho-like Lycaenid.
Species Range: Mexico, Ecuador and Bolivia.
Number: Taken, 2. On two occasions these insects were seen in large numbers. July 15, 1948: 56 seen. July 20: 600 to 700, gleaming in the sun like diminutive morphos. Much slower flight than other lycaenids.
Record: 1948—July 20 (2, 481257, 481258).

Thecla una Hew.

Species Range: Panama, Venezuela, British Guiana and Brazil.
Record: 1948—July 21 (1), 24 (1).

Thecla undulata Hew.

Species Range: Colombia, Ecuador and Brazil.
Record: 1948—June 6 (2).

Leptotes cassius cassius (Cramer).

Field Name: Dwarf Spotted Lycaenid.
Species Range: Mexico to south Brazil and West Indies.
Subspecies Range: Mexico to south Brazil.
Number: Taken, 25. Several days of migrational peaks were noted as follows: May 26, 1948: Counted 500 flying south through the Pass and watched hundreds more. The flight was swift and erratic. June 17: Clouds of many thousands passed for three hours. Many pairs circling about one another. At least 5,000 were seen. June 18: Still passing in large numbers. July 3: Three or four hundred flocking with small hesperids.
Record: 1948—April 27 (1, 48407); May 1 (1, 48437), 18 (1), 21 (4), 23 (1), 25 (1), 26 (2), 29 (1); June 6 (1), 17 (2, 48818), 18 (1), 24 (1); July 2 (1), 3 (1), 13 (1), 15 (2), 21 (3).

Hemiargus hanno hanno (Stoll).

Species Range: Mexico to Guiana and West Indies.
Subspecies Range: Mexico to Guiana.
Record: 1948—July 16 (1).

Migration of Hesperiidae.

Of the large family of Skippers (Hesperiidae), 41 species were recorded as migrants through Portachuelo Pass. These insects have in common a swift, darting flight and the majority have brown as a dominant color, so that in the case of most species identification on the wing is impossible. A commentary on the numerous species, the rarity of many, and the difficulty of catching these insects on their swift flight is shown by the fact that of 26 species (two-thirds of the whole), only single individuals were taken, and of six other forms the total taken was two each. On the other hand, several species were counted in thousands and of one, a hundred thousand was estimated.

Achylodes pallida (Felder).

Field Name: Large Bronze-brown Skipper.

Species Range: Mexico and northern South America.

Field Characters: Large (45 mm.), bronze-brown with wavy, water-mark-like indistinct markings of darker.

Number: Taken, 2.

Record: 1948—April 28 (1, 48423), 29 (1, 481458).

Achylodes thraso (Hübner).

Field Name: Purplish-black Pointed-wing Skipper.

Species Range: Texas to southern Brazil.

Field Characters: Medium, purplish-black, with a few, indistinct lighter spots; forewing pointed.

Record: A single specimen taken. 1948—July 29 (1, 481514).

Aguna coelus (Cramer).

Field Name: Green-based Short-tail Skipper.

Species Range: Mexico to southern Brazil.

Field Characters: Medium, brown, short-tailed, windowed skipper, green sheen on wing bases; white band across under hindwing.

Record: One specimen taken. 1948—July 16 (1, 481490).

Aguna species?

One unidentifiable specimen. Species unknown; white band on underside of wings distinct from other species.

Record: 1948—July 21 (1, 481513).

Amenis pionia (Hew.).

Field Name: Scarlet-dotted White-edge Skipper.

Species Range: Colombia, Venezuela to Argentina.

Field Characters: Basally green, distally brown, all wings with narrow white edge. Two scarlet spots on forewing, two on base of abdomen.

Record: Single specimen taken. 1948—June 5 (1, 481454).

Anisochoria albiplaga (Felder).

Field Name: White-spotted-hindwing Skipper.

Species Range: Colombia and Venezuela to Peru and Argentina.

Field Characters: In general brown, with large, white, round, central patch on hindwing.

Record: Single specimen taken. 1948—July 17 (1, 481479).

Astraptes fulgerator (Walch).

Field Name: Giant White-barred Greenbase Skipper.

Species Range: Texas to southern Brazil.

Field Characters: Very large (60 mm.), brown, with two unequal transparent bars on forewing. Head, body and base of all wings iridescent green.

Record: Single specimen taken. 1948—July 25 (1, 481371).

Augiades crinisus (Cramer).

Field Name: Golden Skipper.

Species Range: Costa Rica to Peru and Amazonia.

Field Characters: Medium (40 mm.). Wings basally golden-orange, dark brown distally, with five irregular groups of transparent spots on forewing. Easily identified on wing because of gold color in spite of rapid, zigzag flight.

Number: This species appeared on migration, in 1948, throughout a period of 22 days, from June 28 to July 19. On the first few days the average was one a day; on following days there were hundreds, reaching a peak of an estimated 35,000 in two and a half hours on July 6, and dropping on the 16th, when only 1,430 were counted in three hours. Three days later the last individual was taken, resting on the roof of Rancho Grande. Twenty-five were taken, 45,000 counted; 100,000 would be a very conservative estimate for those passing, uncounted.

Record: 1948—June 28 (1, 48976), 30 (1, 48998; 300 plus counted); July 2 (6 taken; 100's darting past in company with two other species, mostly *Panoquina sylvicola* and day-flying moths), 3 (again the dominant migrant; 2, 481028; 700 counted in half an hour, a great many missed in count), 4 (1, 481056; 800 counted in fifteen minutes; 1000's passing), 6 (9, 481075; peak of migration: 35,000 between 8 and 10.30 A.M. They then increased, 10 a second. Flew at 10 to 20 feet height); 13 (6,000 estimated); 16 (1 taken, 1,430 counted, 100's missed), 19 (1, 481252, on roof of Rancho Grande).

Autochton zarex (Hübner).

Field Name: Bar-window White-edged-hindwing.

Species Range: Mexico to southern Brazil.

Field Characters: Small, brown, spindle-shaped-window. White edge on hindwing.

Record: Single specimen taken. 1948—July 5 (1, 481072).

Callimormus gracilis (Felder).

Field Name: Small Bronze-brown.
Species Range: Mexico to Peru and Amazons.
Field Characters: Very small (22 mm.), bronzy-brown.
Number: Taken, 3.
Record: 1948—May 1 (1, 481486); July 10 (1), 24 (1, 481488).

Carystus coryna (Hew.).

Field Name: Buff-barred Silver-underwing Skipper.
Species Range: Mexico to Peru and Amazons.
Field Characters: Small, six-dotted window; under hindwing buff-barred silvery.
Record: Single specimen taken. 1948—July 22 (1, 481323).

Celaenorrhinus eligius (Cramer).

Field Name: Twenty-dotted Window.
Species Range: Mexico to Argentina.
Field Characters: Medium (43 mm.), brown, two unequal window bands and scattered dots on forewing.
Number: Taken, 2.
Record: 1948—May 6 (1, 48502), 9 (1, 481483).

Cogia calchas (Herrich-Schaeffer).

Field Name: Black-dot-edged Brown Skipper.
Species Range: Texas to Paraguay.
Field Characters: Small, bronze-brown, dark dots along edge of wings.
Record: Single specimen taken. 1948—July 15 (1, 481480).

Diphoridas phalaenoides (Hübner), form **godmani** Mat. & Bou.

Field Name: Small Marbled Brown Skipper.
Species Range: Neotropics.
Field Characters: Small, light and dark marbled.
Record: Single specimen taken. 1948—July 21 (1, 481477).

Ebrietas anacreon (Staud.).

Field Name: Small Freckled Brown Skipper.
Species Range: Mexico to southern Brazil.
Field Characters: Small, bronzy-brown, freckled with darker.
Record: Single specimen taken. 1948—July 15 (1, 481476).

Entheus priassus (Linn.).

Field Name: Red-banded White-spot Skipper.
Species Range: Panama to Peru, and east through Venezuela, Guianas and Brazil.
Field Characters: Medium, red longitudinal bar, and three broken window bars on forewings; hindwing with very large, central white spot.
Record: Single specimen taken. 1948—July 19 (1♀, 481512).

Eutocus lucia (Capron.).

Field Name: Small Freckled Bronze Skipper.
Species Range: Panama to Bolivia and southern Brazil.
Field Characters: Small (24 mm.), bronze-brown, indistinctly freckled.
Number: Taken, 2.
Record: 1948—April 27 (2, 48414, 48415).

Gorgythion begga begga (Pritt.).

Field Name: Coarse-freckled Bronze Skipper.
Species Range: Mexico to southern Brazil.
Subspecies Range: Mexico to Venezuela.
Field Characters: Small, light-bronze, coarsely dotted with black.
Record: Single specimen taken. 1948—April 26 (1, 48391).

Grais stigmaticus (Mab.).

Field Name: Medium Bronze-brown.
Species Range: Texas to southern Brazil.
Field Characters: Medium (44 mm.), general color bronze-brown. Below, pale golden buff spots are indistinctly visible.
Record: Single specimen taken. 1948—July 3 (1, 481028).

Heliopetes alana (Reak.).

Field Name: Black-tipped White Skipper.
Species Range: Neotropics.
Field Characters: Medium, white with broad black forewing tips, and narrow hind edge. Below with golden tinge to a band in the tips, and a black, central hindwing spot.
Record: Single specimen taken. 1948—July 17 (1, 491474).

Heliopetes arsalte (Linn.).

Field Name: Streak-tipped White Skipper.
Species Range: Mexico to Argentina.
Field Characters: Small (32 mm.). White, streak-tipped forewings; all with narrow dark border. In swift or high flight may be confused with *Heliopetes laviana*.
Number: Total, 950 plus. Taken, 10.
Abundant, especially in late April and early May.
Record: 1948—April 26, 27, 28 and 29 white skippers were common, about 200 or more a day, until a thirty-mile wind drove them to shelter, when I took three and found them to be this species. April 29 (3, 481463; 300 counted going over); May 6 (1, 48503; several hundred flying high); 9 (1 taken, 2 seen); June 11 (1); July 2 (2), 17 (1, 481485).

Heliopetes laviana (Hew.).

Field Name: Buff-edged White Skipper.
Species Range: Venezuela, Ecuador and Peru.
Field Characters: Medium, white, with wide, pale buffy edge, with indistinct darker markings along inner margin of the buff.
Record: Single specimen taken. 1948—May 21 (1, 48542).

Lerodea species?

A single, specifically unidentifiable female. The dark spotted underside of the wings is distinctive.

Milanion hemes albidior (Cramer).

Field Name: White-hind-winged Skipper.
Species Range: Throughout South America.
Subspecies Range: Venezuela.
Field Characters: Small (31 mm.). Transparent spotted dark forewing; black-bordered solid white hindwing. White hind wing makes identification easy.
Number: Total, 83. Taken, 4.
Record: 1948—April 26 (1, 48391; flashing hind wings on leaf); May 6 (2, 48501, 48503), 23 (30 seen), 24 (43 seen); June 6 (1 taken, 2 seen).

Mnasitheus simplicissima (Herrich-Schaeffer).

Field Name: Small Brown Skipper.
Species Range: Mexico to Argentina.
Field Characters: Small (22 mm.), brown skipper.
Record: Single specimen taken. 1948—July 14 (1, 481117).

Mylon lassia (Hew.).

Field Name: Mottled Cream Skipper.
Species Range: Mexico to Bolivia.
Field Characters: Forewing mottled with various browns, hindwing pale, dotted with darker. Below, pale cream.
Record: Single specimen taken. 1948—May 1 (1, 481462).

Mylon ozema (Butler).

Field Name: Brown-freckled Pearly-white Skipper.
Species Range: Mexico to Peru, and Colombia to Trinidad.
Field Characters: Medium (38 mm.). Pearl white, iridescent in sun. Faintly brown, tipped and sparsely brown-edged. Dusky wing base.
Number: Total, 475 plus. Taken, 15.
Record: 1948—June 6 (3), 17 (2, 48822), 22 (1, 48881. Abundant this day. 58 counted in few minutes, and 100's of others passing in erratic flight. Resemble lycaenids, but much faster flight). July 8 (2, 48881a and 488881b), 15 (5), 21 (1).

Panoquina sylvicola (Herrich-Schaeffer).

Field Name: Ten-windowed Skipper.
Species Range: Mexico to southern Brazil.
Field Characters: Small, brown, five windows in each forewing, two bars and three dots.
Number: Thousands seen. Taken, 11.
Record: 1948—June 26 (1, 48923); July 2 (5, 481025, 481056), 13 (1), 16 (2), 21 (1), 23 (1), 29 (1).

Phanus marshalli (Kirby).

Field Name: Skeleton-winger Skipper.
Species Range: Mexico to Peru and the Amazons.
Field Characters: Medium (45 mm.), brown, with an intricate pattern of transparent bands, slits and spots. Transparent and opaque areas are about equal.
Record: Single specimen taken. 1948—July 14 (1, 481170).

Pholisora cupreiceps (Mab.).

Field Name: Small Freckled Bronze.
Species Range: Mexico to Bolivia and Brazil.
Field Characters: Small dark brown, obscurely freckled with darker.
Record: Single specimen taken. 1948—May 1 (1, 481525).

Pholisora hazelae Haywood.

Field Name: Small Dark-brown Skipper.
Species Range: Colombia, Venezuela and Ecuador.
Field Characters: Small (28 mm.), brown, hind wings darker.
Number: Taken, 2.
Record: 1946—July 5 (1). 1948—April 27 (1, 48415).

Pholisora sinepunctis (Kaye).

Field Name: Small Dark Bronze-brown.
Species Range: Venezuela and Trinidad.
Field Characters: Small brown skippers; characterless on the wing.
Number: Taken, 3.
Record: 1948—May 1 (1, 481481), 5 (1, 481482); July 15 (1).

Proteides exadeus exadeus (Cramer).

Field Name: Giant Golden-buff Skipper.
Species Range: Neotropics.
Subspecies Range: Northern South America.
Field Characters: Large (60 mm.), brown with basal half of wings golden-buff; large window spots, short, rounded tails.
Number: Taken, 2.
Record: 1948—May 1 (1, 481449); July 15 (1, 481491).

Proteides mercurius (Fabr.).

Field Name: Narrow-winged Golden Skipper.
Species Range: Neotropics.
Field Characters: Narrow, long forewings, basal half of all golden.
Record: Single specimen taken. 1948—July 16 (1, 481475).

Pyrgus orcus (Cramer).

Field Name: Small White-spotted Brown Skipper.
Species Range: Salvador south throughout South America.
Field Characters: Small, grayish-brown, everywhere conspicuously dotted and spotted with white.
Number: Taken, 7.
Record: 1948—April 24 (2 taken, male and female), 30 (1, 481461); May 25 (1, 481487); July 15 (2), 19 (1, 481253).

Pyrrhopyge phidias (Linn.).

Field Name: Shining-green White-edge Skipper.

Species Range: Colombia and Venezuela to Argentina.

Field Characters: Large (50 mm.), dark shining green, wings with very narrow white edge. Head and abdomen end chestnut.

Record: Single specimen taken. 1948—May 6 (1, 48506).

Remella remus (Fabr.).

Field Name: Small Bronze-brown.

Species Range: Neotropics.

Field Characters: Small brown skipper, wholly characterless on wing.

Record: Single specimen taken. 1948—July 20 (1, 481336).

Rhinthon anthracinus (Mab.).

Field Name: Medium Dark-brown Skipper.

Species Range: Colombia and Trinidad to Bolivia.

Field Characters: Medium (36 mm.), brown. Characterless on wing.

Record: Single specimen taken. 1948—June 15 (1, 481478).

Urbanus dorantes (Stoll).

Field Name: Long-tailed Bronze Skipper.

Species Range: Neotropics.

Field Characters: Medium (38 mm.), light bronze-brown, long tails, seven square window spots in each wing.

Number: Thousands seen. Taken, 7. Migrating with *Augiades crinisus* but in fewer numbers.

Record: Whenever taken, many hundreds passed uncounted. 1948—April 28 (1, 48422), 29 (2, 481460); May 1 (1); June 24 (1, 48898); July 14 (1).

Urbanus eurycles (Latr.).

Field Name: Long-tailed Brown Skipper.

Species Range: Texas to Paraguay.

Field Characters: Medium brown, elongated hind wings and tails, two narrow window slits on forewing.

Record: Single specimen taken. 1948—July 24 (1, 481493).

Urbanus proteus (Linn.).

Field Name: Long-tailed Shining-green Skipper.

Species Range: New York to southern Brazil.

Field Characters: Brown, very elongate hind wings and tails, center of hind wing shining green. Large square windows.

Number: Taken, 2.

Record: 1948—May 9 (1); July 17 (1, 481492).

EXPLANATION OF THE PLATE.

Plate I.

Fifty-five species of butterflies of the family Nymphalidae taken as migrants at Portachuelo Pass, Rancho Grande, north-central Venezuela.

Fig. 1. *Euptoieta hegesia hegesia.*
Fig. 2. *Phyciodes carme carme.*
Fig. 3. *Phyciodes clio estabana.*
Fig. 4. *Phyciodes drusilla drusilla.*
Fig. 5. *Phyciodes leucodesma.*
Fig. 6. *Phyciodes liriope anieta.*
Fig. 7. *Chlosyne janais hyperia.*
Fig. 8. *Chlosyne lacinia saundersii.*
Fig. 9. *Chlosyne narva.*
Fig. 10. *Vanessa virginiensis braziliensis.*
Fig. 11. *Junonia evarete zonalis.*
Fig. 12. *Hypanartia dione.*
Fig. 13. *Hypanartia lethe.*
Fig. 14. *Anartia amathea amathea.*
Fig. 15. *Anartia jatrophae jatrophae.*
Fig. 16. *Eunica caralis indigophana.*
Fig. 17. *Eunica monima.*
Fig. 18. *Eunica* near *viola.*
Fig. 19. *Dynamine theseus.*
Fig. 20. *Dynamine mylitta* (male).
Fig. 21. *Dynamine mylitta* (female).
Fig. 22. *Dynamine getae* (male).
Fig. 23. *Dynamine getae* (female).
Fig. 24. *Dynamine glauce* (male).
Fig. 25. *Dynamine glauce* (female).
Fig. 26. *Callicore machalii.*
Fig. 27. *Callicore metiscus.*
Fig. 28. *Perisama humboldtii humboldtii.*
Fig. 29. *Perisama xenocles.*
Fig. 30. *Catagramma pitheas.*
Fig. 31. *Hamadryas amphinome amphinome.*
Fig. 32. *Hamadryas februa februa.*
Fig. 33. *Hamadryas fornax fornax.*
Fig. 34. *Didonis biblis biblis.*
Fig. 35. *Cystineura bogotana.*
Fig. 36. *Pseudonica flavilla sylvestris.*
Fig. 37. *Pyrrhogyra edocla edocla.*
Fig. 38. *Pyrrhogyra neaerea juani.*
Fig. 39. *Marpesia chiron chiron.*
Fig. 40. *Marpesia coresia.*
Fig. 41. *Marpesia marcella* (male).
Fig. 42. *Marpesia marcella* (female).
Fig. 43. *Marpesia peleus.*
Fig. 44. *Victorina apaphus.*
Fig. 45. *Victorina stelenes stelenes.*
Fig. 46. *Adelpha boeotia boeotia.*
Fig. 47. *Adelpha celerio celerio.*
Fig. 48. *Adelpha irmina irmina.*
Fig. 49. *Adelpha lara lara.*
Fig. 50. *Adelpha olynthia inachis.*
Fig. 51. *Chlorippe cyane cyane.*
Fig. 52. *Historia acheronta acheronta.*
Fig. 53. *Smyrna blomfildia blomfildia.*
Fig. 54. *Prepona antimache andicola.*
Fig. 55. *Prepona chromus chiliarches.*
Fig. 56. *Prepona demophon centralis.*
Fig. 57. *Anaea pseudiphis.*
Fig. 58. *Anaea xenocles.*
Fig. 59. *Protogonius hippona trinitatis.*

Plate II.

Riodinidae.

Fig. 1. *Euselasia russata.*
Fig. 2. *Hades noctula.*
Fig. 3. *Mesosemia,* near *magete.*
Fig. 4. *Lymnas iarbas iarbas.*
Fig. 5. *Diorina dysonii,* form *dysonii.*
Fig. 6. *Mesene margaretta.*
Fig. 7. *Mesene silaris.*
Fig. 8. *Baeotis choroniensis.*
Fig. 9. *Argyrogramma holosticta.*
Fig. 10. *Sarota acantus.*
Fig. 11. *Imelda kadenii.*
Fig. 12. *Theope eudocia acosma.*

Brassolidae.

Fig. 13. *Caligo eurilochus caesia.*
Fig. 14. *Caligo atreus ajax.*
Fig. 15. *Caligo teucer teucer.*
Fig. 16. *Opsiphanes cassina merianae.*

Morphidae.

Fig. 17. *Morpho peleides corydon.*

Libytheidae.

Fig. 18. *Libytheana carimenta carimenta.*

MIGRATION OF NYMPHALIDAE (NYMPHALINAE), BRASSOLIDAE, MORPHIDAE, LIBYTHEIDAE, SATYRIDAE, RIODINIDAE, LYCAENIDAE AND HESPERIIDAE (BUTTERFLIES) THROUGH PORTACHUELO PASS, RANCHO GRANDE, NORTH-CENTRAL VENEZUELA.

MIGRATION OF NYMPHALIDAE (NYMPHALINAE), BRASSOLIDAE, MORPHIDAE, LIBYTHEIDAE, SATYRIDAE, RIODINIDAE, LYCAENIDAE AND HESPERIIDAE (BUTTERFLIES) THROUGH PORTACHUELO PASS, RANCHO GRANDE, NORTH-CENTRAL VENEZUELA.

2.

Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Paralepididae.[1]

ROBERT R. HARRY.
Natural History Museum, Stanford University, California.

(Text-figures 1-9).

CONTENTS.

INTRODUCTION.

The Bermuda Oceanographic Expeditions of the New York Zoological Society, under the direction of Dr. William Beebe, obtained a very interesting and valuable collection of paralepids, comprising several hundred specimens, of which approximately 250 have been sent to me for study. The remainder of the material could not be located. This material provides a new genus, *Stemonosudis*, the second records for *Macroparalepis brevis, M. danae, Stemonosudis intermedia* and *Lestidium affine*, the third record for *Macroparalepis affine*, and the first complete ontogenetic series of *Paralepis brevirostris*. In addition the writer gives the first extensive description since the middle 1800's of adults of the remarkable *Sudis hyalina*. Examples of the family Paralepididae are rare in most museums and thus it is of interest to report that most of the Bermuda material has been deposited at Stanford University. A duplicate series has been retained by the New York Zoological Society. In addition to the Bermuda collections, Atlantic material from Mr. G. E. Maul of the Museu do Funchal, Madeira, from the H. H. Giglioli Collection at the Museo di Storia Naturale, Roma, and from the British Museum (Natural History), has been incorporated in this paper. The work was done in the Natural History Museum of Stanford University.

Beebe (1937), in his preliminary list of Bermuda deep-sea fishes, lists tentative determinations of 753 paralepids, consisting of three genera (*Luciosudis, Paralepis* and *Macroparalepis*) and seven species. The genus *Luciosudis* is not included in the present report because it does not belong to the family Paralepididae, but instead to the suborder Myctophoidea in the neighborhood of the family Chlorophthalmidae. The specimen of *Macroparalepis intermedius* is here included as *Stemonosudis intermedia*. *Paralepis bronsoni* and *P. speciosus?* are included under *P. brevis*. *Paralepis brevirostris* and *P. brevis* are left as originally determined.

For data in regard to nets, localities, depths, etc., concerning the capture of paralepids treated in this report, the reader may refer to the articles by Dr. Beebe in *Zoologica* (1931a, 1931b, 1932, 1936).

The classification and methods of investigation here used are explained in detail in a series of papers by the present author under the title "Studies on the bathypelagic fishes of the family Paralepididae" now in press in *Pacific Science*. A considerable part of the results of this study of the Bermuda material is included in the studies referred to, and in order to reduce duplication to a minimum, the present paper can be considered as number four of the series.

ACKNOWLEDGMENTS.

I am greatly indebted to the New York Zoological Society and also to Dr. William Beebe and Mr. John Tee-Van for allowing me to examine the Bermuda material and for their considerate cooperation during the preparation of this report. I also wish to thank Dr. Enrico Tortonese for helping me locate material of *Sudis hyalina* and Mr. G. E. Maul for supplying valuable paralepids.

EXPLANATION OF MORPHOLOGICAL FIGURES.

The full-page morphological figures have been prepared in a standard manner to facilitate comparison of some of the more important morphological characters. Similar illustrations of other genera and species will be found in the author's papers mentioned above.

Figure A.—Anterior part of snout. The teeth that are solid black are depressible;

[1] Contribution No. 892, Department of Tropical Research, New York Zoological Society.

the remainder are fixed. The buccal valves and supramaxillary membranes are stippled. The nostrils on the snout and the larger pores on the lower jaw are indicated.

Figure B.—An enlarged section of the fixed teeth on the middle of the premaxillary viewed laterally.

Figure C.—The anterior lateral-line segments on the left side. The area with longitudinal parallel lines delimits the partly ossified center shield in the naked genera (*Lestidium* and *Macroparalepis*) and the central row of scales in the scaled genus *Paralepis*. The crossed lines indicate the scales above and below the middle lateral-line row.

Figure D.—A section of the ceratobranchial of the first right arch showing the gill-teeth. The parallel lines indicate the gill arch.

Figure E.—Dorsal surface of tongue (glossohyal) and anterior portion of first basibranchial. The stippled area represents the fleshy tongue. The glossohyal and basibranchial are indicated by longitudinal parallel lines. The small hooked circles indicate the teeth.

Methods for Counts and Measurements.

The methods used here for counts and measurements are explained in order to avoid confusion. In general they are the same as presented by Hubbs & Lagler (1947).

Measurements.—The *standard length* is the distance from the anterior tip of the snout to the base of the caudal fin. The *body length* is the distance from the posterior tip of the operculum to the base of the caudal fin. The *body depth* is the greatest dimension, exclusive of the fleshy or scaly structures which pertain to the fin bases. It is not of much use due to the irregular development and preservation of the carinae. The *caudal peduncle length* is the oblique distance betwen the end of the dorsal base and mid-base of the caudal fin. The *head length* is the distance from the tip of the snout (upper jaw) to the most distant point on the opercular margin including membranous flaps. The *eye diameter* is the greatest distance between the free orbital rims. The *interorbital width* is the least bony width. The *upper jaw length* is the distance between the tip of the snout and the posteriormost point of the maxillary. The *predorsal, preanal* and *prepelvic* distances are the lengths between the anterior tip of the snout and the origins of the corresponding fins. Note that *preanal* is used here in respect to the anal fin, while Ege uses this term in relation to the anus. The *dorsal to pelvic distance* is the length between the dorsal fin origin and a vertical from the pelvic fin origin. The percentages and proportions were calculated mathematically.

Counts.—The last two closely applied fin rays in the dorsal and anal fins are counted as one. The number of pelvic rays include the outer closely applied rays which are fairly short and the inner rays that are imbedded in the flesh and easily overlooked. The caudal fin count is the number of principal rays only, and includes the branched rays plus one unbranched ray on each side. The upper caudal rays are given first in each count. In regard to dentition on the gill arch it is fully realized that true gillrakers are not known in any families of the suborder Alepisauroidea. Instead the gill arches are armed with teeth (termed "gill-teeth" by various authors) characteristically arranged on bony basal elements. However, for convenience in this study and for want of a better term, I have called each bony base a gillraker and have paid particular attention to the distribution of teeth (gill-teeth) on these "rakers." The distribution and form of the gill arch teeth provide convenient characters for distinguishing most of the paralepid genera.

Family Paralepididae.

The Paralepididae form the second largest family in the order Iniomi (Myctophidae is the largest by far), consisting of seven genera and approximately 45 known species. The Bermuda material includes at least eight species (because some specimens had become dried out, all the species represented are not included) and all genera but *Notolepis* and *Sudis*. The family belongs to the suborder Alepisauroidea and is most closely related to the families Scopelarchidae, Evermannellidae and Omosudidae. The basic recent papers on Atlantic paralepids are by Ege (1930, 1933), Parr (1928, 1929, 1931), and Maul (1945). A discussion of these contributions is given by the present author (in press).

The superficial family characters in brief are: Body slender and elongate. Eye normally directed laterally. Symphysis of lower jaw more or less elevated. There is a corresponding arched, toothless notch in the upper jaw. Angle of gape well before vertical from anterior margin of eye. Supramaxillary present, splinter-like, approximately one-half the length of the maxillary. Teeth on vomer absent or consisting of one or two minute teeth. Teeth on palatines fairly short, not entering into the lateral profile when mouth is open. Teeth on tongue tiny, if present. Dorsal fin with few rays, far back on body, behind pectoral fins and middle of body length. Anus in region of pelvic fins.

Genus **Paralepis** Cuvier.

The genus *Paralepis* is primarily characterized by (1) the presence of a foramen in the anterior process of the premaxillary, (2) upper jaw reaching to or slightly beyond a vertical from anterior border of eye, (3) supramaxillary free from maxillary except at its posterior insertion, (4) teeth on lower jaw short and weak, basally round, (5) gill-teeth consisting of a series of bony bases each armed with numerous teeth in several rows, the anteriormost gill-teeth prolonged, (6) body scaled in adults. The genus *Paralepis* includes six species, of which *P.*

elongata (Brauer), *P. speciosa* Bellotti and *P. danae* Ege (1933) are not included in the present paper.

Despite careful search, no specimens were found in the Bermuda collection which seemed to agree with *Paralepis bronsoni* (Parr). This is strange, considering the wide distribution of species of this genus and the intensive collecting that was carried out reasonably near the type locality (Bahamas) of *P. bronsoni*. Since the subadults of the very similar *P. brevirostris* (Parr) have such a large number of premaxillary teeth it might be possible that Parr's specimen was precocious in development and is actually an aberrant example of *P. brevirostris*. Both Ege and I are inclined to believe that *P. bronsoni* is an unusual or abnormal specimen of *P. brevirostris*.

Paralepis brevirostris (Parr).

Text-figs. 1-3.

Specimens Taken by the Bermuda Oceanographic Expeditions.—Fifty-nine specimens, 8.5-50.0 mm. in standard length; April 29, 1929, to July 24, 1934, at 25 to 2,000 fathoms; from a cylinder of water eight miles in diameter (five to thirteen miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.

No. 9,589; net 34; 700 F.; April 29, 1929; 24.9 mm.
No. 9,615; net 47; 600 F.; April 29, 1929; 26.0 mm.
No. 9,815; net 78; 600 F.; May 8, 1929; 29.0 mm.
No. 9,900; net 89; 600 F.; May 10, 1929; 32.0 mm.
No. 9,952; net 100; 600 F.; May 14, 1929; 31.5, 32.3 mm.
No. 10,094; net 117; 900 F.; May 18, 1929; 12.5 mm.
No. 10,253a; net 135; 600 F.; May 30, 1929; 12.3 mm.
No. 10,727; net 195; 700 F.; June 20, 1929; 25.3 mm.
No. 24,080; net 205; 500 F.; June 22, 1929; 16.3 mm.
No. 24,087; net 217; 500 F.; June 24, 1929; 13.3 mm.
No. 24,106; net 243; 600 F.; July 1, 1929; 13.2 mm.
No. 11,267; net 259; 1000 F.; July 5, 1929; 11.8 mm.
No. 11,293a; net 260; 500 F.; July 6, 1929; 11.8, 12.2 mm.
No. 11,633; net 305; 600 F.; July 16, 1929; 42.7 mm.
No. 12,119; net 356; 700 F.; Aug. 9, 1929; 10.7 mm.
No. 13,636; net 356; 700 F.; Aug. 9, 1929; 16.7, 19.4 mm.
No. 12,433; net 382; 900 F.; Aug. 16, 1929; 14.5 mm.
No. 13,171a; net 432; 700 F.; Sept. 6, 1929;
No. 13,733a; net 497; 1000 F.; Sept. 23, 1929; } 3 specimens 16.5-21.0 mm.
No. 13,735; net 497; 1000 F.; Sept. 23, 1929
No. 15,497; net 645; 600 F.; May 29, 1930; 9.3 mm.
No. 17,388; net 746; 800 F.; June 30, 1930; 8.5 mm.
No. 17,389; net 804; 500 F.; July 16, 1930; 12.5 mm.
No. 17,829; net 843; 700 F.; Sept. 4, 1930; } 21.8, 23.5 mm.
No. 17,838; net 844; 800 F.; Sept. 4, 1930;
No. 18,284; net 865; 600 F.; Sept. 10, 1930; 18.6 mm.
No. 20,703; net 1003; 500 F.; June 6, 1931; 19.0 mm.
No. 20,714; net 1007; 800 F.; June 6, 1931; 35.7 mm.
No. 20,775; net 1008; 600 F.; June 6, 1931; 43.4 mm.
No. 20,868; net 1021; 600 F.; June 16, 1931; 16.3 mm.
No. 21,080; net 1052; 300 F.; July 6, 1931; 13.2 mm.
No. 21,431a; net 1084; 25 F.; July 11, 1931; 11.1 mm.
No. 21,481; net 1095; 600 F.; July 24, 1931; 35.0 mm.
No. 21,753; net 1119; 400 F.; Aug. 3, 1931; 3 specimens 12.7-13.0 mm.
No. 21,934; net 1137; 600 F.; Aug. 6, 1931; } 38.7 mm.
No. 21,944; net 1138; 600 F.; Aug. 6, 1931;
No. 22,536; net 1198; 1000 F.; Aug. 17, 1931; 13.8 mm.
No. 22,716; net 1213; 900 F.; Aug. 21, 1931; 15.8, 18.9 mm.
No. 22,862; net 1239; 900 F.; Aug. 29, 1931; 22.3 mm.
No. 23,066; net 1257; 800 F.; Sept. 3, 1931; 12.4 mm.
No. 23,104; net 1261; 600 F.; Sept. 4, 1931; 12.3 mm.
No. 23,167; net 1271; 600 F.; Aug. 7, 1931; } 4 specimens 14.6-28.5 mm.
No. 23,207; net 1275; 1000 F.; Aug. 7, 1931;
No. 23,259; net 1282; 500 F.; Aug. 10, 1931; } 3 specimens 16.5-23.4 mm.
No. 23,283; net 1285; 800 F.; Aug. 10, 1931;
No| 23, 295; net 1288; 2000 F.; Aug. 11, 1931; 50.0 mm.
No. 23,298; net 1290; 500 F.; Sept. 12, 1931; 12.5, 13.3 mm.
No. 23,590; net 1313; 500 F.; Sept. 17, 1931; 15.0 mm.
No. 23,665; net 1326; 600 F.; Aug. 19, 1931; part of body
No. 23,897; net 1332; 600 F.; Oct. 28, 1931; 25.9 mm.
No. 24,372; net 1501; 400 F.; July 24, 1934; 15.0 mm.

Other Study Material.—Two specimens, 68.9 and 135.5 mm. in standard length; originally Museu do Funchal nos. 2484 and 2983; larger specimen now Stanford no. 15081; collected from the stomachs of *Alepisaurus ferox* Lowe near Madeira, North Atlantic; obtained from G. E. Maul. These specimens were described by Maul (1945, p. 9).

Specimens Previously Recorded.—Twenty-six specimens, 53-195 mm. in standard length, have been recorded in the literature by Parr

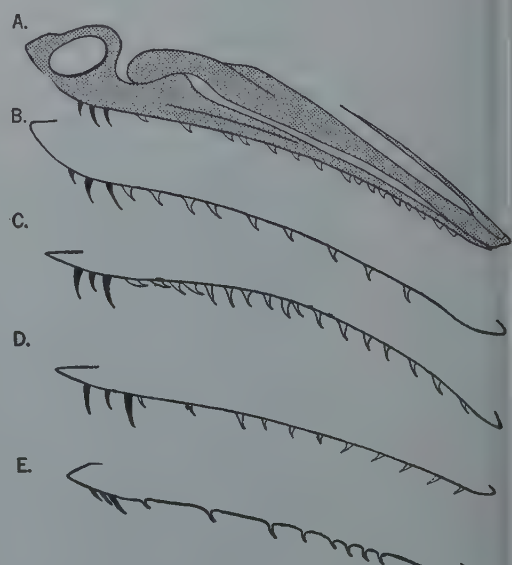
TEXT-FIG. 1. Post-larva, 13.4 mm. in standard length, of *Paralepis brevirostris* (Parr). All pigmentation that can be seen when viewed laterally is indicated. The occiput and nape are heavily pigmented, but this coloration is not included in the illustration because the top of the head is broad and flat. Note the broad base of the pectoral fin, the extension of the fin far under the head, and the considerably shortened anterior rays. The pectoral fin moves posteriorly in later growth stages, the base becomes considerably more restricted, and the anterior rays become longer correspondent to the other pectoral rays.

(1928, p. 42; 2 types from off the Bahama Islands. 1929, p. 31; osteology of one of the types) and Maul (1945, p. 9; 24 specimens collected from the stomachs of *Alepisaurus ferox* Lowe taken near Madeira). For the complete history of this species see Parr (1928, 1931), Ege (1930) and Maul (1945).

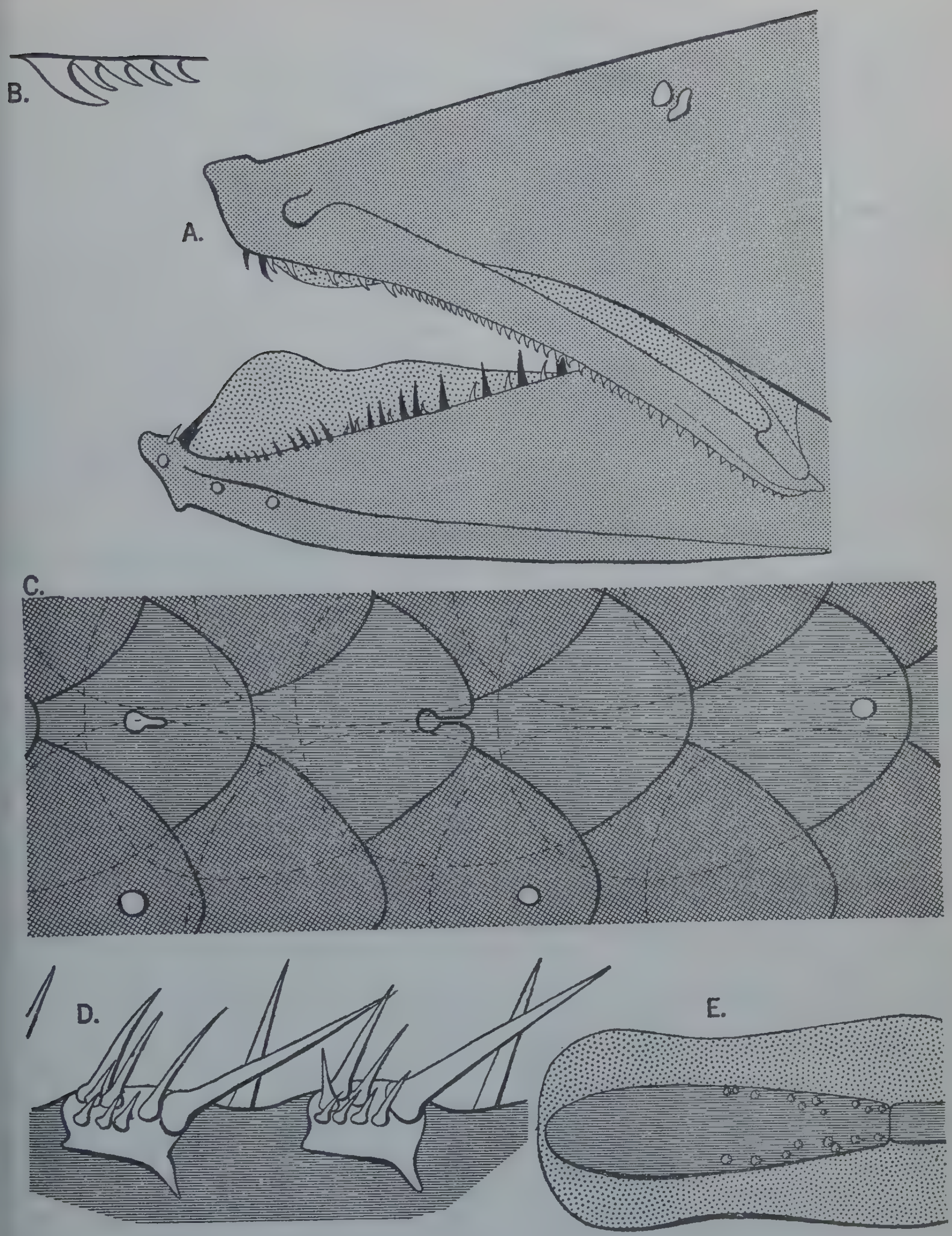
Post-Larval Development.—The smallest specimen previously described is the holotype, 53 mm. in standard length, from off the Bahamas. The description of the osteology of this form by Parr (1929) must also be of an adolescent or juvenile. Maul (1945) described specimens down to 56 mm. in length from off Madeira, but he did not give particular attention to the ontogeny displayed by his material. Nevertheless, there appears to be no reason to doubt that all of Maul's material belongs to this species. In order to facilitate uniformity in work done on North Atlantic paralepids, the style of Ege (1930) has been fairly closely followed in presenting descriptions of the various growth stages of *Paralepis brevirostris*. Particular attention has been paid to comparison of this form with its closest relative, *Paralepis speciosa* Bellotti, as presented by Ege (1930, p. 51). It can be easily seen that the larval stages of these two species are remarkably different. The primary differences reside in the facts (1) that *P. brevirostris* is distinctly larger than *P. speciosa* at corresponding growth stages, and (2) that the former species is much more heavily pigmented in every stage.

Post-larva 13.1 *mm. in Standard Length.*—All of the fins and fin rays are fully developed, except that the pelvics are still lacking. The fin rays can all be counted and the supplementary caudal rays are suggested. The embryonic fin fold is almost completely reduced in front of the well developed adipose fin; ventrally a deep fin extends from below the pectorals to the anal fin origin, but is only slightly evident between anal and caudal fins. There are nine closely spaced peritoneal color segments of which the first is the largest. The peritoneal segments extend far down the sides and these patches become progressively smaller posteriorly so that the last four are reduced to small spots. The four anterior segments cover the stomach. The occiput and nape are heavily pigmented. Scattered chromatophores before eye and on posterior tip of upper jaw. Otherwise no pigmentation on head and body.

Post-larva 23.4 *mm. in Standard Length.*—The pelvic fins are slightly posterior to the anus, but the rays are not discernible. The adipose fin is sharply defined, but is still preceded by a very low embryonic fin fold; ventrally the embryonic fin extends from below the pectoral fins to the anal fin but is



TEXT-FIG. 2. Upper jaw of various growth stages of *Paralepis brevirostris* (Parr). The solid black teeth are depressible and are inserted on the inner face of the premaxillary; the remainder are fixed and are situated on the edge of the premaxillary. **A.** 50.0 mm. in standard length. **B.** 35.0 mm. **C.** 26.0 mm. **D.** 13.2 mm. **E.** 9.3 mm. The maxillary bones have been drawn in A. The premaxillary is denticulated and contains a large anterior foramen. The next largest bone is the maxillary, and the small slender bone anteriorly free is the supramaxillary. This series shows that while there is a general trend for the increase in number of fixed teeth in subsequent growth stages, there is considerable individual variation. In most paralepids the number of premaxillary teeth is highly variable, even within definite growth stages.



TEXT-FIG. 3. Adult of *Paralepis brevirostris* (Parr) 135.6 mm. in standard length. See "Explanation of Morphological Figures" (Pages 16 & 17).

well developed only between the anus and anal fin; embryonic fold only slightly evident between anal and caudal fins. Anus below middle of dorsal fin. There are six closely spaced peritoneal color segments which are confined to the sides of the abdominal cavity, extending far down ventrally. The posterior two peritoneal segments are less than one-third the size of the fourth; the first four segments are nearly the same size, but the first is the largest. The remainder of the pigmentation is quite different from the preceding stage. The dorsum is heavily pigmented from occiput to dorsal origin and with slightly scattered chromatophores halfway down over the sides. The hind-dorsal stripe continues on the sides, below the dorsal fin, back to under the adipose fin; this section is confined to above the vertebral column. There are scattered chromatophores on the gular region, snout and particularly on the postorbital part of the head.

Adolescent 31.5 *mm. in Standard Length.* —The proportions and appearance of the

adult have been somewhat developed by this stage. The dorsal portion of the embryonic fin has disappeared; ventrally it is developed from under the third peritoneal color segment to the anal fin origin. The pelvic fins are fully formed below the dorsal fin and the rays can be counted. There are five large, distinct, closely spaced peritoneal color segments which posteriorly blend into the solid pigmentation of the body. The head and body are heavily pigmented except on the belly and opercles. The body is solidly pigmented above and behind the peritoneal segments, particularly so in the mid-dorsal stripe. The head is heavily pigmented on post-orbital, nape, occiput and tip of snout; scattered chromatophores elsewhere. The fins lack pigment, except the bases of the anterior rays of the dorsal fin and the upper pectoral ray. Gill-teeth and pharyngobranchial teeth are not developed. The lateral-line tube is poorly developed, but the body skin is densely penetrated by minute pores, forming a striking parallel to the condition found in the adults of the families Anotopteridae and Alepisauridae. Each lateral-line segment has a single median pore. This is of particular interest since the most primitive genus in the family (new genus, in press) has this same condition in the adult of a single pore for each lateral-line section. A few of the lateral-line and neighboring scales are developed (these were discerned by superficially staining with Alizarin Red S).

Adolescent 43.4 *mm. in Standard Length.* —This specimen is essentially the same as the previously described adolescent, except that it is less pigmented. There are nine peritoneal color segments, the pigmentation on the body is restricted to the dorsum and the sides over the anal fin. The anus is slightly behind the pelvic fin base and a vertical from the dorsal fin base. No scales evident. The lateral-line as in the previous stage. Gill-teeth just beginning to develop; each spinous raker consisting of one or two short, sharp, conical teeth. The bony raker bases have not yet developed. Pharyngobranchial teeth not developed.

Juvenile 50.0 *mm. in Standard Length.*— The gill-teeth are essentially fully developed on each arch with approximately 4-6 subequal spines on each bony raker base. Some of the pharyngobranchial teeth are developed. Lateral-line segments fully developed and ossified, but still a single pore for each segment. A few scales developed in the lateral-line region. Otherwise this specimen is essentially the same as the previous example described.

Subadult 68.9 *mm. in Standard Length.*— Scales well developed in the lateral-line region. The adult pore pattern along the lateral-line is now evident. The gill-teeth are longer than in previous stage and either the anteriormost or the inner middle spine is the longest on each bony base. Pharyngobranchial teeth well developed. The peritoneal segments (eight in number) are reduced and weakly pigmented.

Adult 135.6 *mm. in Standard Length.*— The adults of this species have been carefully described by Maul (1945), including this specimen, but additional notes are presented in the light of my own investigations.

Interorbital concave with two pairs of low sharp ridges near the orbital margins; these ridges strongly diverge laterally on occiput: the inner pair of ridges converge anteriorly on snout and unite behind the premaxillary process; the outer two ridges are parallel to the inner ridges and converge (but do not join) behind premaxillary process. Maxillary terminates slightly before a vertical from the anterior border of the eye. Posterior tip of supramaxillary broad, flat, inserted on the outer face of the maxillary. Nostrils approximately one-third the length of the upper jaw in front of a vertical from the posterior tip of the maxillary. Premaxillary anteriorly with three small depressible canines followed by nine small, irregularly arranged, retrorse teeth; abruptly behind these teeth are 44 tiny, closely spaced, sub-equal, retrorse canines. Tip of lower jaw blunt, lacking any trace of anterior unossified projections. Vomer toothless. Palatines anteriorly with two large, fixed, retrorse canines and five long, depressible canines; posteriorly a single row of 10 various-sized, fixed, retrorse canines. Last palatine tooth slightly behind angle of gape. Tongue large, with two longitudinal rows of 8-10 teeth. Gill-teeth on all five arches. Each gillraker has approximately 5-12 depressible teeth in each bunch; the anterior and inner spines are the longest, and the anteriormost spine is particularly prolonged. Gill-teeth extend anteriorly to slightly behind a vertical from tip of upper jaw. On first arch, eight rakers on hypobranchial, nine on ceratobranchial, three above angle on epibranchial.

Lateral-line with 55 sections, terminating slightly behind a vertical from the middle of the anal fin. Lateral-line tube covered by two rows of scales; scales irregularly pierced by pores. The basic pattern appears to be a single median pore near the posterior margin in both scale rows. Often no pores present on scales. Lateral-line scales same shape and size as body scales. Each lateral-line scale is bordered above and below by one scale. The underlying segments of the lateral-line are only weakly ossified.

Anus at tips of appressed pelvic fins.

Stomach Contents Recorded by Beebe.— The stomach contents of 15 *Paralepis brevirostris* were examined before preservation and recorded by Dr. Beebe in his field notes. The length refers to standard length.

Number	Net	Length	Food
14,904	565	12 mm.	2 small *Phronima.*
15,309	621	13 mm.	small shrimp.
15,330	625	10 mm.	shrimp 8 mm.
15,338	626	12 mm.	2 small fish 8 mm.
15,831	686	15 mm.	small fish 12 mm.
16,119	719	16 mm.	2 oblique-eyed *Myctophum* larvae.
16,603	766	17 mm.	shrimp 10 mm.
16,853	792	14 mm.	4 large copepods.
17,013	798	17 mm.	small fish.
17,146	804	20 mm.	small fish 12 mm.
18,281	865	16 mm.	small fish 10 mm., small shrimp.
18,635	893	28 mm.	shrimp 16 mm.
19,568	967	14 mm.	2 myctophid larvae 8 mm.
19,568	967	29 mm.	4 small *Acanthephyra.*

Paralepis brevis (Zugmayer).

Specimens Taken by the Bermuda-Oceanographic Expeditions. — One hundred and sixty-eight specimens, 8.0-85 mm. in standard length; August 16, 1929, to October 28, 1931, at 300 to 1,000 fathoms; from a cylinder of water eight miles in diameter (five to thirteen miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.

No. 11,646; net 307; 800 F.; July 16, 1929; 85 mm.
No. 12,424; net 380; 700 F.; Aug. 16, 1929; 8 specimens 13.3-25.0 mm.
No. 12,557; net 391; 600 F.; Aug. 19, 1929;
No. 12,563; net 392; 700 F.; Aug. 19, 1929; 18 specimens
No. 12,576; net 393; 800 F.; Aug. 19, 1929; 9.8-23.2 mm.
No. 17,006; net 797; 500 F.; July 15, 1930;
No. 17,390; net 797; 500 F.; July 15, 1930;
No. 13,209; net 437; 500 F.; Sept. 7, 1929; 4 specimens 9.4-22.4 mm.
No. 13,221; net 439; 700 F.; Sept. 7, 1929;
No. 13,698; net 493; 600 F.; Sept. 23, 1929;
No. 13,703; net 494; 700 F.; Sept. 23, 1929; 6 specimens 12.9-27.8 mm.
No. 13,713; net 495; 800 F.; Sept. 23, 1929;
No. 12,632; net 486; 700 F.; Sept. 21, 1929;
No. 13,638; net 487; 800 F.; Sept. 21, 1929; 6 specimens 13.4-23.0 mm.
No. 13,646; net 488; 900 F.; Sept. 21, 1929;
No. 13,656; net 489; 1000 F.; Sept. 21, 1929;
No. 14,722; net 541; 800 F.; May 6, 1929; 9.8 mm.
No. 14,823; net 551; 500 F.; May 9, 1929; 10.6 mm.
No. 14,904; net 565; 500 F.; May 12, 1930; 9.7 mm.
No. 14,906; net 565; 500 F.; May 12, 1930; 10.1 mm.
No. 15,205; net 596; 600 F.; May 19, 1930; 13.0 mm.
No. 15,277; net 618; 500 F.; May 22, 1930; 10.5, 10.6 mm.
No. 15,309; net 621; 600 F.; May 22, 1930; 13.0 mm.
No. 15,338; net 626; 500 F.; May 23, 1930; 12.1, 12.1 mm.
No. 15,343; net 626; 500 F.; May 23, 1930;
No. 15,571; net 651; 500 F.; May 30, 1930; 13.2 mm.
No. 15,575; net 652; 500 F.; May 30, 1930; 13.3 mm.
No. 15,831; net 686; 800 F.; June 9, 1930; 16.0 mm.
No. 15,890; net 694; 900 F.; June 12, 1930; 17.0 mm.
No. 15,986; net 708; 500 F.; June 16, 1930; 13.3 mm.
No. 16,119; net 719; 700 F.; June 25, 1930; 13.3 mm.
No. 16,177; net 725; 500 F.; June 26, 1930; 10.4, 12.7 mm.
No. 16,312; net 741; 1000 F.; June 28, 1930; 13.0 mm.
No. 16,422; net 746; 800 F.; June 30, 1930; 12.2 mm.
No. 16,440; net 754; 700 F.; July 1, 1930; 3 specimens 14.3-18.6 mm.
No. 16,607; net 767; 800 F.; July 3, 1930; 14.0 mm.
No. 16,716; net 781; 1000 F.; July 5, 1930; 12.4, 20.2 mm.
No. 16,781; net 784; 500 F.; July 7, 1930; 12.1 mm.
No. 16,775; net 785; 600 F.; July 7, 1930; 12.3, 18.1 mm.
No. 16,846; net 791; 500 F.; July 9, 1930; 3 specimens 10.0-12.5 mm.
No. 16,853; net 792; 600 F.; July 9, 1930; 12.0 mm.
No. 17,013; net 798; 600 F.; July 15, 1930; 4 specimens 13.0-17.0 mm.
No. 17,386; net 805; 600 F.; July 16, 1930; 3 specimens 11.3-14.8 mm.
No. 18,693; net 901; 600 F.; Sept. 17, 1930; 19.5 mm.
No. 19,221; net 934; 700 F.; Sept. 23, 1930; 14.7, 15.3 mm.
No. 20,518; net 983; 500 F.; June 2, 1931; 11.6 mm.
No. 20,644; net 995; 1000 F.; June 4, 1931; 10.8 mm.
No. 20,778; net 1009; 900 F.; June 11, 1931; 10.4, 12.0 mm.
No. 20,818; net 1016; 500 F.; June 15, 1931; 11.2 mm.
No. 20,867; net 1021; 600 F.; June 16, 1931; 6 specimens 11.8-13.0 mm.
No. 20,897; net 1026; 1000 F.; June 16, 1931;
No. 21,258; net 1073; 300 F.; July 10, 1931; 12.1 mm.
No. 21,308; net 1078; 300 F.; July 11, 1931; 11.6 mm.
No. 21,415; net 1086; 300 F.; July 15, 1931; 10.0 mm.

No. 21,483; net 1095; 600 F.; July 24, 1931;	14.8, 15.6 mm.
No. 21,499; net 1099; 900 F.; July 24, 1931;	
No. 21,543; net 1102; 500 F.; July 25, 1931;	19.5, 21.2 mm.
No. 21,554; net 1103; 600 F.; July 25, 1931;	
No. 21,606; net 1107; 400 F.; July 27, 1931;	12 specimens 10.4-25.7 mm.
No. 21,618; net 1108; 500 F.; July 27, 1931;	
No. 21,637; net 1112; 900 F.; July 27, 1931;	
No. 21,683; net 1113; 400 F.; July 29, 1931;	4 specimens 10.6-21.1 mm.
No. 21,707; net 1115; 500 F.; July 29, 1931;	
No. 21,767; net 1120; 400 F.; Aug. 3, 1931;	3 specimens 11.6-18.0 mm.
No. 21,797; net 1121; 500 F.; Aug. 3, 1931;	
No. 21,843; net 1127; 900 F.; Aug. 4, 1931;	13.8 mm.
No. 21,934; net 1137; 600 F.; Aug. 6, 1931;	17.3 mm.
No. 21,944; net 1138; 600 F.; Aug. 6, 1931;	
No. 22,003; net 1144; 500 F.; Aug. 7, 1931;	16.8, 19.6 mm.
No. 22,018; net 1147; 700 F.; Aug. 7, 1931;	
No. 22,054; net 1150; 500 F.; Aug. 8, 1931;	3 specimens 15.9-20.6 mm.
No. 22,065; net 1152; 600 F.; Aug. 8, 1931;	
No. 22,074; net 1154; 700 F.; Aug. 8, 1931;	
No. 22,153; net 1155; 400 F.; Aug. 10, 1931;	5 specimens 11.1-22.6 mm.
No. 22,158; net 1156; 500 F.; Aug. 10, 1931;	
No. 22,325; net 1175; 600 F.; Aug. 14, 1931;	3 specimens 14.5-20.7 mm.
No. 22,398; net 1182; 700 F.; Aug. 15, 1931;	22.7, 23.8 mm.
No. 22,649; net 1205; 700 F.; Aug. 20, 1931;	20.7 mm.
No. 22,776; net 1218; 700 F.; Aug. 24, 1931;	22.0, 27.3 mm.
No. 22,779; net 1222; 1000 F.; Aug. 24, 1931;	
No. 22,794; net 1227; 400 F.; Aug. 27, 1931;	3 specimens 10.5-21.5 mm.
No. 22,801; net 1228; 500 F.; Aug. 27, 1931;	
No. 22,802; net 1229; 800 F.; Aug. 27, 1931;	
No. 22,945; net 1242; 600 F.; Aug. 31, 1931;	15.8, 18.7 mm.
No. 23,168; net 1271; 600 F.; Aug. 7, 1931;	13.2, 13.8 mm.
No. 23,211; net 1276; 500 F.; Aug. 9, 1931;	9.8, 10.0 mm.
No. 23,220; net 1277; 600 F.; Aug. 9, 1931;	16.5, 23.9 mm.
No. 23,231; net 1278; 700 F.; Aug. 9, 1931;	
No. 23,260; net 1282; 500 F.; Aug. 10, 1931;	5 specimens 21.4-35.6 mm.
No. 23,267; net 1283; 600 F.; Aug. 10, 1931;	
No. 23,291; net 1287; 1000 F.; Aug. 10, 1931;	
No. 23,325; net 1293; 800 F.; Sept. 12, 1931;	16.3, 30 mm.
No. 23,333; net 1295; 1000 F.; Sept. 12, 1931;	
No. 23,374; net 1299; 900 F.; Sept. 14, 1931;	19.0 mm.
No. 23,419; net 1305; 500 F.; Sept. 15, 1931;	30.3 mm.
No. 23,562; net 1314; 600 F.; Sept. 17, 1931;	23.6, 25.8 mm.
No. 23,661; net 1325; 500 F.; Aug. 19, 1931;	3 specimens 18.3-35.7 mm.
No. 23,667; net 1326; 600 F.; Aug. 19, 1931;	
No. 23,898; net 1332; 600 F.; Oct. 28, 1931;	app. 20 mm.

Other Study Material Examined.—One specimen 98.5 mm. in standard length; originally Museu do Funchal no. 3021; now Stanford no. 15082; collected from the stomach of *Alepisaurus ferox* Lowe (caught on a tunny-hook at about 100 fathoms) from near Madeira, North Atlantic; obtained from G. E. Maul.

Specimens Previously Recorded. — Approximately 35 specimens from larvae to adults described by many authors. See Ege (1930) and Maul (1945) for history and synonymy.

Description of Material.—Ege (1930) has already described and figured the early post-embryonic growth stages and several authors have described the adults. Certain adult characters are here described in more detail.

Interorbital deeply concave with two pairs of low sharp longitudinal ridges near orbital margins on each side; the inner ridges diverge somewhat laterally on occiput. The outer pair of ridges is confined to the interorbital. The inner ridges extend forward to premaxillary processes, but do not converge or unite. Premaxillary anteriorly with five fairly short, depressible canines followed by 49 tiny, closely spaced, retrorse teeth. The fixed teeth become progressively larger posteriorly, except for the last two much smaller teeth. Tip of lower jaw blunt, rounded, lacking anterior unossified prolongations. Vomer toothless. Palatines anteriorly with three short depressible canines, each accompanied by a shorter fixed tooth; posteriorly 14 fixed teeth extending far behind angle of gape. Teeth on all five gill arches. Each bony base on first arch has approximately 4-7 depressible spines in a bunch; the anterior spines are the longest. Teeth begin slightly before a vertical from anterior border of eye. On first arch, 10 rakers on hypobranchial, 18 on ceratobranchial, and eight above angle on epibranchial.

Field Color Notes Prepared by Beebe.—*No.* 21,308, *Net* 1078, 12 *mm. Post-larva*. The entire fish is white with black chromatophores arranged in patches as follows: on the tip of the snout, midway between tip of snout and eye, along the isthmus and margins of the jaws, and on the crown of the head. Several are located just behind the orbit, two at the dorsal origin, a large blotch at the origin of the anal, two below the

adipose and one on either side of the mid-line. The digestive organs are blackish and show prominently through the skin of the abdomen. Iris bluish-silver with violet reflections, overlaid anteriorly and dorsally with a great deal of pigment.

No. 22,776, *Net* 1218, 33 *mm. Adolescent.* General color white, with well developed black, dendritic chromatophores over the entire head and body except on the ventral side of the trunk. This is unmarked, save at the base of the anal and below the adipose, where the characteristic larval pigment patches still remain. The pigment is densest along the dorsal mid-line. Iris silvery.

Paralepis coregonoides (Risso).

Specimens Taken by the Bermuda Oceanographic Expeditions. — Three specimens, 11.7-74 mm. in standard length; June 21 and Sept. 1, 1929, at 600 to 1,000 fathoms; from a cylinder of water eight miles in diameter (five to thirteen miles south of Nonsuch Island, Berumda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.

No. 10,769; net 204; 1000 F.; June 21, 1929; 74 mm.
No. 22,001; net 1248; 600 F.; Sept. 1, 1929; } 11.7, 34.0 mm.
No. 22,996; net 1249; 700 F.; Sept. 1, 1929; }

Other Material Examined.—Two specimens 139.7 (originally Museu do Funchal no. 2937) and 142.8 mm. (now Stanford no. 15,083) in standard length; from the stomachs of *Alepisaurus ferox* Lowe (caught on tunny-hook at about 100 fathoms); obtained from G. E. Maul. The larger specimen was described by Maul (1945, p. 22).

Specimens Previously Recorded.—Several hundred specimens from the North Atlantic. For synonymy and discussion see Ege (1930) and Maul (1945).

Description of Madeira Material.—The various growth stages of this species have been carefully described by several authors, but additional notes concerning the adults are presented in the light of my own investigations.

Interorbital strongly concave with two pairs of low, sharp ridges near the orbital margins on each side; posteriorly these ridges strongly diverge laterally on occiput; the inner pair of ridges converges anteriorly on snout and unites behind the premaxillary process. Premaxillary anteriorly with four tiny, depressible canines followed by 38 tiny, closely spaced, retrorse teeth. Tip of lower jaw blunt, lacking any trace of anterior unossified prolongations. Vomer toothless. In the larger specimen, palatines anteriorly with a single row of retrorse canines; two fixed teeth followed by a longer depressible canine, and approximately 13 short teeth. In other adult, palatines with three depressible canines followed by around 10 fixed teeth. Last palatine tooth far behind angle of gape in both specimens. Tongue toothless. Teeth on all five arches. All the bony rakers the same. Each bony raker base has approximately 5-10 depressible spines in a bunch; the anterior spines are the longest, and the anteriormost is particularly prolonged. Teeth begin distinctly before eye behind posterior tip of upper jaw. On first arch, 12 bony bases on hypobranchial, 14 on ceratobranchial, and six above angle on epibranchial.

Lateral-line with approximately 60 sections, terminating slightly behind a vertical from the middle of the anal fin. Lateral-line tube covered by two rows of scales; scales irregularly pierced by pores. The basic pattern is a single pore near the lower margins of both scale rows. Often no pores present or a single median pore on each side of the lower scale row. Each lateral-line scale same size as surrounding scales and bordered above and below by one scale. The underlying segments are only weakly ossified.

Anus above tips of appressed pelvic fins and behind a vertical from dorsal fin.

The Madeira specimen is illustrated in the generic review in press.

Field Color Notes Prepared by Beebe.—*No.* 10,769, *Net* 204, 90 *mm.* (before preservation). Body color pale flesh, probably where scales were; there is an irregular scattering of large dusky pigment cells. Dark on head, down dorsal ridge, and on the whole posterior two-fifths of the body. All fins black. Iris silvery. Gill covered with brilliant blue and green iridescence. Whole body cavity, from isthmus to anus, glittering, opaque silver with dark pigment showing at edges.

Genus **Notolepis** Dollo.

The genus *Notolepis* is primarily characterized by (1) the presence of a foramen in the anterior process of the premaxillary, (2) upper jaw terminating approximately an orbital diameter before the eye, (3) supramaxillary closely bound to maxillary, (4) teeth on lower jaw well developed, basally round, not reduced in adults, (5) gill-teeth numerous, sub-equal, in numerous rows, (6) body scaled in adults.

This genus includes three species of bipolar distribution: *Notolepis coatsi* Dollo (generic type) from the Antarctic, *N. rissoi* (Bonaparte) from the North Atlantic, and *N. coruscans* (Jordan & Gilbert) from the North Pacific. The Bermuda Expeditions did not obtain this genus, but I have examined an adult of *N. rissoi* obtained by the U.S.S. *Albatross* in 1886 that does not appear to have been recorded in the literature.

Notolepis rissoi (Bonaparte).

Material Examined.—One adult 251.5 mm. in standard length; Stanford no. 9491; Albatross station 2677; May 6, 1886; 32° 39′ 00″ N. Lat., 76° 50′ 30″ W. Long.

Specimens Previously Recorded. — Approximately 70 specimens from 13 to about

300 mm. in standard length, described by many authors from the eastern Atlantic. See Ege (1930) for history of this species.

Description of Material.—This specimen is partially digested, but fin ray counts and proportions clearly indicate that this is *N. rissoi* and very likely the subspecies *krøyeri* Lütken. This specimen is of particular interest since apparently it is the first record of a larger specimen from off the coast of the Americas. The only other report of the species from the western Atlantic appears to be Ege's record of two post-larvae from off the central Atlantic sea-board of the United States (1930, p. 105).

Genus **Lestidium** Gilbert.

The genus *Lestidium* is primarily characterized by (1) the presence of a foramen in the anterior process of the premaxillary, (2) upper jaw terminating at or well before a vertical from anterior border of eye, (3) supramaxillary closely bound to maxillary, (4) teeth on lower jaw well developed, basally round, not reduced in adults, (5) gill-teeth reduced, sub-equal, in a single row, (6) body naked, (7) lateral-line sections approximately as long as high, (9) dorsum of body evenly pigmented.

This genus is by far the largest in the family, including about 22 species, and is generally world-wide in distribution.

Lestidium affine (Ege).

Text-fig. 4.

Specimens Taken by the Bermuda Oceanographic Expeditions.—One specimen, 65.3 mm. in standard length; no. 20,779; net 1009; 900 fathoms; June 11, 1931; from a cylinder of water eight miles in diameter (five to thirteen miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.

Specimens Previously Recorded.—At least 160 type specimens from post-larvae to subadults 103 mm. long, described by Ege (1930, p. 81), from the central and temperate North Atlantic. Neither holotype nor actual number of types was given. Apparently no other record has been published for this species.

Description of Bermuda Juvenile.—Body elongate, slender. Greatest depth at nape 14.8 into standard length. Ventral carina on belly and betwen anus and anal fin well developed. Dorsal carina before adipose fin a slight ridge. Caudal peduncle depth 5.6 into head; its length 2.8 into standard length. Anus above tips of appressed inner pelvic rays, situated slightly greater than an eye diameter before a vertical from the dorsal fin origin.

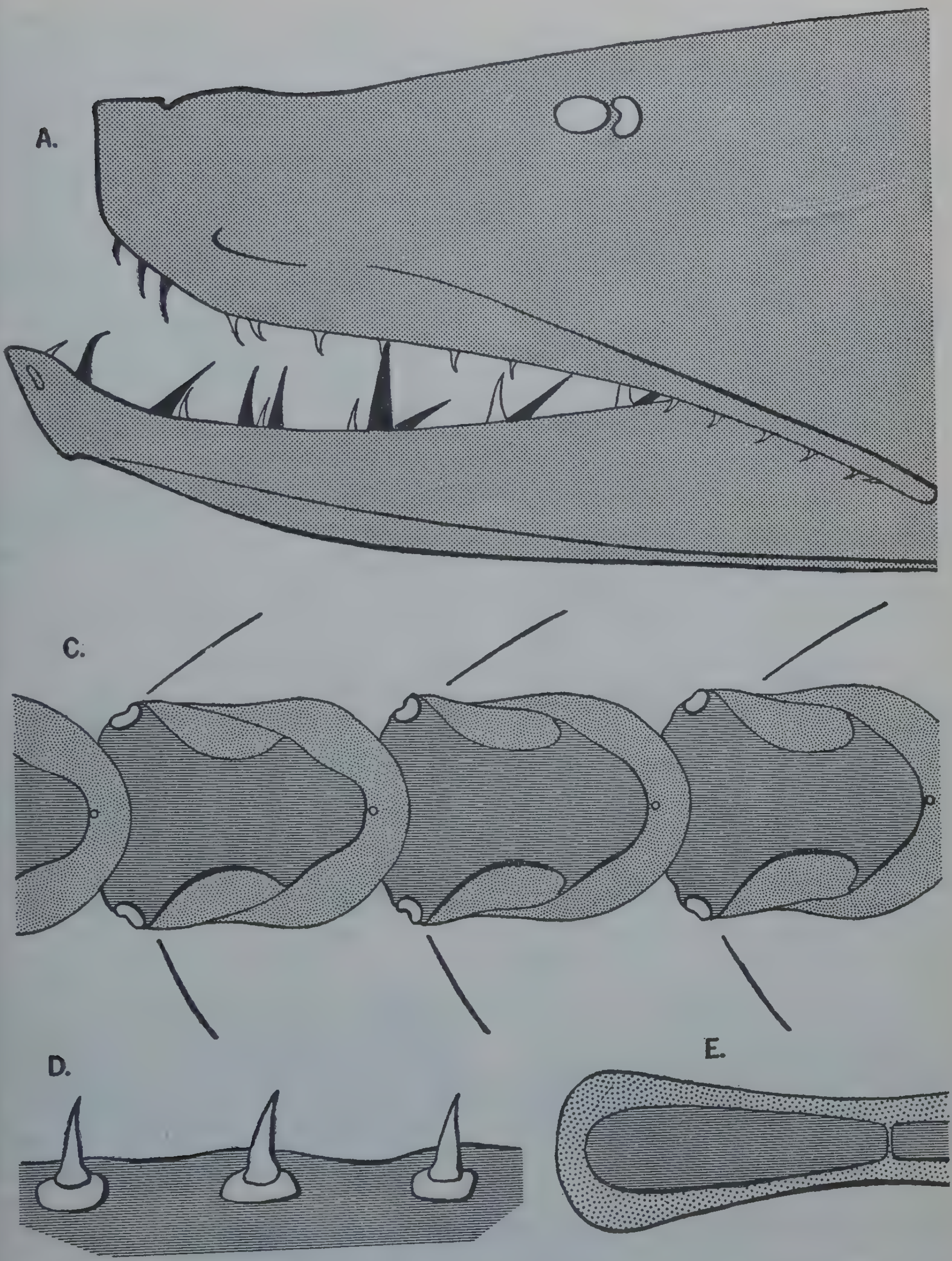
Head short, blunt, and fairly massive, slightly broader than body width; its length 6.2 into standard length. Snout short, distinctly less than one-half head length. Nasal apertures situated somewhat less than one-half the upper jaw length before its posterior tip. Eye vertically oval, its length 4.8 into head. Pupil obliquely oval. Postorbital length less than snout length. Interorbital flat, its width 5.6 into head, with two longitudinal ridges; ridges of the inner pair are broad, low, rounded tubes, and those of the lateral pair are sharp, compressed, but very short. Occiput strongly convex, with one pair of ridges on each side leading into tubes, directed obliquely inward from the upper posterior margin of each orbit. Tip of lower jaw without anterior unossified prolongations. Upper jaw length 2.1 into head, terminating slightly before a vertical from the anterior border of the eye. Premaxillary anteriorly with three long, depressible canines, followed by six retrorse, fixed canines and six antrorse fixed canines. Mandible with eight widely spaced canines, each accompanied by a short fixed tooth. Palatines anteriorly with four long, depressible canines, the last accompanied by a short fixed canine; after a space there are two short, fixed, retrorse canines in a single row. The last palatine tooth is slightly behind angle of gape. Tongue naked, but with a few rudiments of teeth near first basibranchial. Gill-teeth rudimentary, six bony raker bases, each with a single tooth, developed on ceratobranchial of first arch. A few pharyngobranchial teeth developed. Pseudobranchiae consisting of five long tufts.

Dorsal fin with nine rays. Origin of dorsal distinctly behind middle of body length, approximately one-third the distance between anal and pelvic fins behind the pelvic fins. Predorsal distance 1.7 into standard length. Dorsal to pelvic distance distinctly longer than either snout or upper jaw. Length of dorsal base 5.3 into head. Adipose fin low and long, free from caudal fin, over last anal rays. Anal rays 27. Length of anal base 5.9 into standard length.

Pectoral fins placed very low with 11 rays on both sides, their length 2.7 into head. Pelvic fins with 9 rays on both sides, far before middle of body length. Prepelvic distance 2.0 into standard length. Caudal with 9 + 10 rays.

Lateral-line with 60 segments, terminating over anterior portion of anal fin. Each lateral-line segment has rounded, shield-like, partly ossified sections. Each anterior section contains one pore above and below near the anterior margin. In the posterior sections there is the addition of a median pore, which is absent in the last segments over the anal fin.

Coloration.—Dorsal band very light and narrow, not extending onto lateral-line. Lateral-line and sides of body without pigmentation, except scattered chromatophores near caudal base. Mid-ventral line between anus and anal fin with eight chromatophores in a single line. Anterior rays of anal fin and upper ray of pectoral fin with scattered chromatophores. Other fins lacking pigment. Lightly scattered chromatophores on snout, lower part of mandible, supraorbital margin and suborbital region. Occiput fairly heavily pigmented.



TEXT-FIG. 4. Juvenile of *Lestidium affine* (Ege) 65.3 mm. in standard length. See "Explanation of Morphological Figures" (Pages 16 & 17).

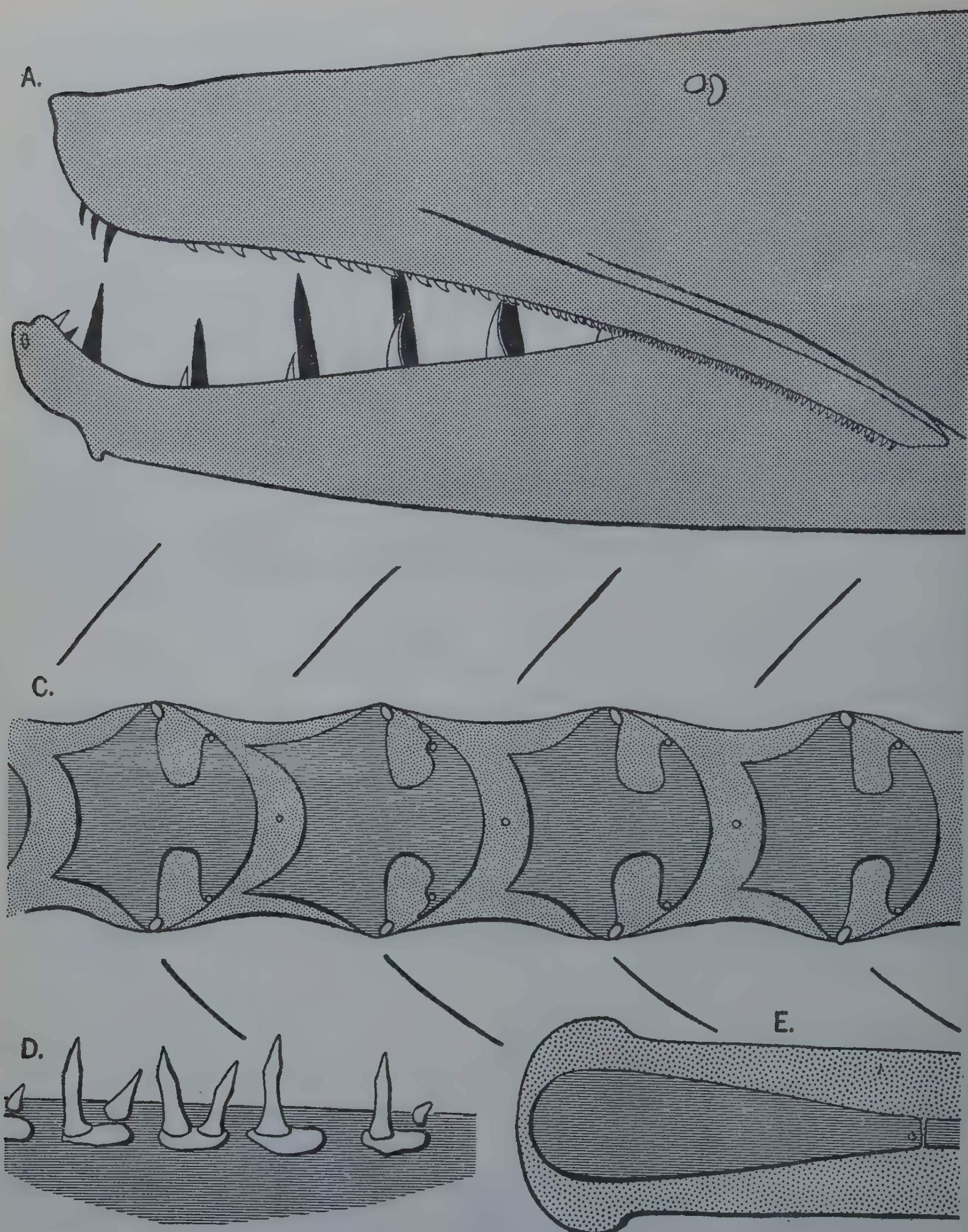
Measurements in Percent. of Standard Length. — Greatest body depth 6.7; least depth of caudal peduncle 2.9; length of caudal peduncle 36.1; length of head 16.2; length of snout 7.4; eye diameter 3.4; width of interorbital 2.9; predorsal distance 59.2; length of dorsal base 3.0; dorsal to pelvic distance 11.0; preanal distance 79.9; length of anal base 16.8; length of pectoral fin 6.1; length of pelvic fin 5.8.

Lestidium pseudosphyraenoides danae (Ege).

Text-fig. 5.

Material Examined.—One specimen, 168.5 mm. in standard length, from Funchal Harbor, Madeira (taken at night near surface); Stanford no. 15,084; obtained from G. E. Maul.

Specimens Previously Recorded. — This subspecies is known from the 33 types, ap-



TEXT-FIG. 5. Adult of *Lestidium pseudosphyraenoides danae* (Ege) 168.5 mm. in standard length. See "Explanation of Morphological Figures" (Pages 16 & 17).

proximately 28-36 mm. in standard length, from the temperate North Atlantic, described by Ege (1930, p. 79) and four specimens, 100-187 mm. in standard length, from off Madeira, described by Maul (1945, p. 24).

Description of Madeira Adult.—Interorbital strongly concave, with two pairs of longitudinal ridges which diverge anteriorly. Occiput flat, with two pair of ridges on each side leading into tubes directed obliquely inward from the upper posterior margin of orbit. Premaxillary anteriorly with three depressible canines followed by 85 closely spaced, retrorse canines; the posterior teeth tend to become antrorse. Tip of lower jaw with three prominent vertical unossified prolongations. Vomer toothless. Palatines anteriorly with three large, hooked canines, each accompanied by a short fixed tooth; posteriorly 11 short fixed canines in a single row. Last palatine tooth far behind angle of gape. Tongue (glossohyal) with a median fixed tooth near first basibranchial. Teeth well developed on all five arches. Each bony raker base with one or two short spines. Bony rakers on first arch 10 on hypobranchial, 16 on ceratobranchial, seven above angle on epibranchial. Gill-teeth begin below

middle third of eye. Pharyngobranchial teeth well developed in one oval patch on each side, consisting of about 25 depressible canines.

Lateral-line with 76 sections, terminating over a vertical from beginning of hind third of anal fin. Each lateral-line segment with the double-concave center shield characteristic of the genus *Lestidium*. Each anterior section contains two pores above and below near the anterior margin. In the middle sections there is the addition of a median pore between the partially ossified shields, but in the last sections over the anal fin there is only one pore above and below.

Genus *Macroparalepis* Ege.

The genus *Macroparalepis* is primarily characterized by (1) the presence of a foramen in the anterior process of the premaxillary, (2) upper jaw terminating at or slightly before a vertical from the anterior margin of the orbit, (3) supramaxillary closely bound to maxillary, (4) teeth on lower jaw well developed, basally round, not reduced in adults, (5) gill-teeth reduced, sub-equal, in a single row, (6) body naked in adults, (7) lateral-line sections distinctly deeper than long, (8) dorsum of body speckled with large chromatophores, (9) anus situated behind a vertical from the dorsal fin origin.

This genus includes four species from the North Atlantic and South Pacific. Two species of *Macroparalepis* were collected by the Bermuda Expeditions and a third is described from Madeira material. The species not included is *M. egei* Maul, which is known only from a single specimen.

Macroparalepis brevis Ege.

Text-figs. 6 & 7.

Specimens Taken by the Bermuda Oceanographic Expeditions. — Five specimens, 47.0-98.3 mm. in standard length; May 6, 1929, to July 25, 1934, at 500 to 600 fathoms; from a cylinder of water eight miles in diameter (five to thirteen miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.

No. 10,254; net 140; 500 F.; May 31, 1929; 55.1 mm.
No. 14,735; net 539; 600 F.; May 6, 1929; 47.0 mm.
No. 14,776; net 545; 600 F.; May 7, 1929; 56.6 mm.
No. 20,601; net 991; 600 F.; June 4, 1931; 53.5 mm.
No. 24,358; net 1503; 600 F.; July 25, 1934; 98.3 mm.

Specimens Previously Recorded. — One adolescent 135 mm. in standard length from south-east of St. Helena (Lat. 19° 16′ S., Long. 1° 48′ W.), described by Ege (1933, p. 231).

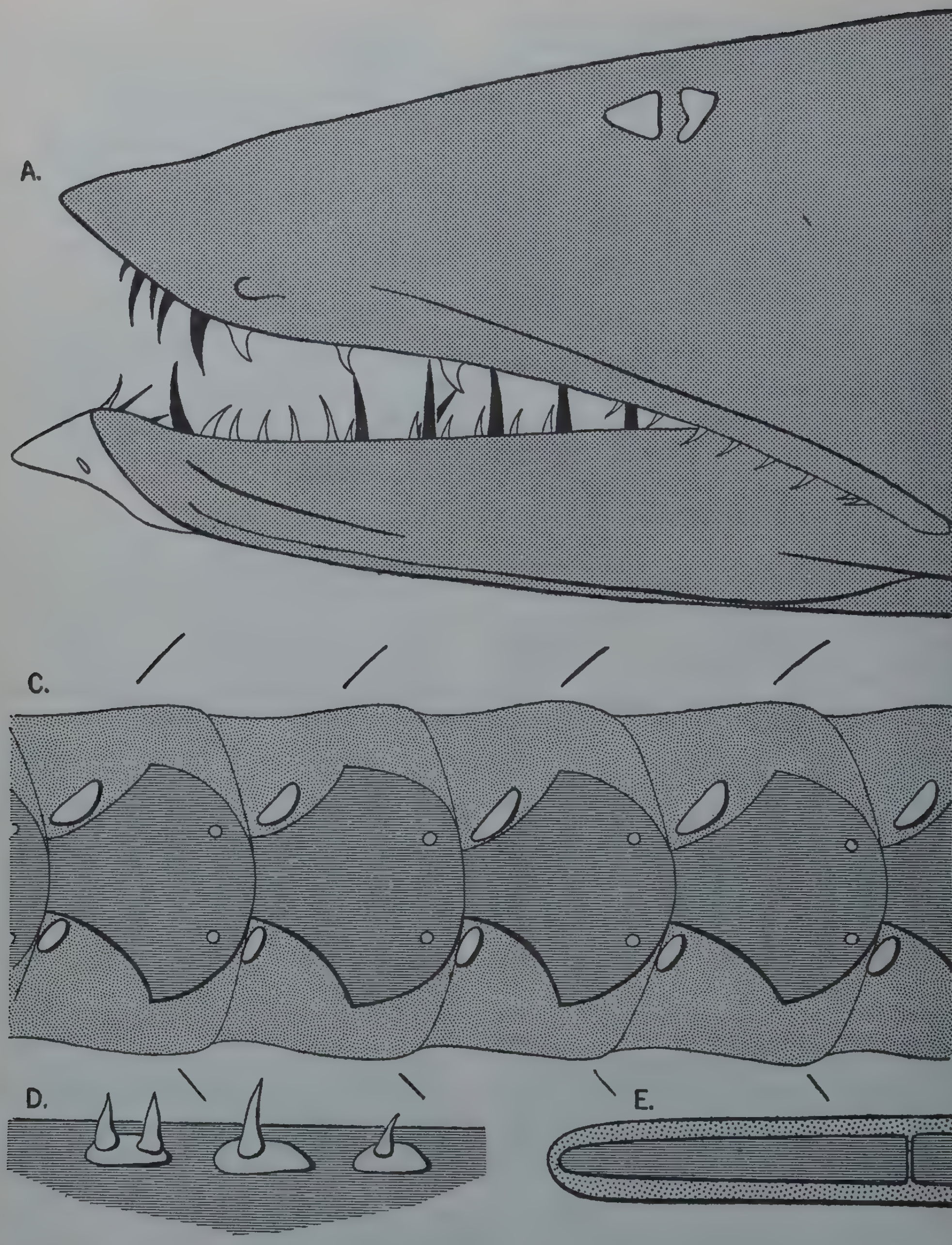
Description of Bermuda Material 47.0-56.6 *mm.*—In the counts and measurements, the mean is given first, followed by the range of three of the four specimens (no. 14,735 not in good enough condition to be counted and measured) in parentheses.

Body elongate, moderately short for a paralepid, compressed; greatest depth at nape 15.4 (14.5-16.2) into standard length. Ventral carina only slightly developed. No dorsal carina. Caudal peduncle depth 5.2 (5.1-5.5) into head; its length 3.3 (3.3-3.4) into standard length. Anus behind pelvic fin base and dorsal fin base, more than an eye diameter before a vertical from the dorsal fin.

Head large, slightly larger than body width; its length 5.0 (4.7-5.3) into standard length. Nostrils situated slightly less than one-half the length of the upper jaw before its posterior tip. Eye round, its length 4.7 (4.3-5.1) into head. Pupil round. Postorbital length distinctly less than snout or upper jaw length. Interorbital flat, with a single pair of sharp longitudinal ridges near the orbital margin; medially a closely spaced pair of rounded ridges extends onto the anterior part of the interorbital. Occiput convex, with a longitudinal median hump; with one (and vestiges of a second) pair of ridges on each side leading into tubes, directed obliquely inward from the upper posterior margin of each orbit. Tip of lower jaw with a hooked unossified prolongation. Upper jaw length 2.0 (1.9-2.0) into head, terminating slightly before a vertical from the anterior border of eye. In largest specimen, premaxillary with five long depressible canines in front, plus six retrorse fixed canines; behind are eight antrorse fixed canines. Smallest specimen with five depressible canines, plus six retrorse fixed teeth, followed by seven antrorse fixed canines. Mandible with approximately nine teeth in double series, the inner row depressible, the outer fixed. Vomer toothless. Palatines anteriorly with one to three fairly long depressible canines followed by 6-8 short, fixed teeth in a single row. Last palatine tooth far behind angle of gape. Tongue toothless. Gill-teeth rudimentary; in the largest specimen, 10 rakers on ceratobranchial of first arch, each with one or two spines. Pseudobranchiae consisting of five long tufts.

Lateral-line with approximately 60-68 segments, terminating over anterior portion of anal fin. Lateral-line segments large and deep, with rounded shield-like sections, without double-concave ossifications. Each lateral-line section contains a very large pore above and below near the anterior margin, and one small pore above and below near the posterior margin. No median pores.

Dorsal fin with 12 (11-12) rays. Origin of dorsal fin distinctly behind middle of body length, approximately one-third the distance between the anal and pelvic fins behind the pelvic fins. Predorsal distance 1.4 (1.4-1.5) into standard length. Dorsal to pelvic distance distinctly shorter than either snout or upper jaw length. Length of dorsal base 4.3 (3.9-4.7) into head. Adipose fin low, free from caudal fin, over last anal rays. Anal



TEXT-FIG. 6. *Macroparalepis brevis* Ege 53.5 mm. in standard length. See "Explanation of Morphological Figures" (Pages 16 & 17).

rays 22 (20-24). Length of anal base 6.5 (6.4-6.6) in standard length. Pectoral fins fairly low, with 10 (10) rays on each side. Pelvic fins with 9 (9) rays on each side, situated slightly before middle of body length. Prepelvic distance 1.6 (1.6-1.7) into standard length. Caudal fin with 9+10 (9+10 or 10+10) rays.

Coloration.—Dorsal band with large and small chromatophores, appearing to be speckled, extending down upon upper border of lateral-line. Five long, slender, peritoneal color segments developed posteriorly to above pelvic fins. Scattered chromatophores on jaw, snout and occiput.

Description of Bermuda Specimen of 98.3 *mm.*—Since this adolescent is different in many respects from the other four specimens it is described separately. Unless otherwise indicated, this specimen agrees with the description of the smaller specimens.

Stomach full of a great number of postlarval fish. Greatest depth of body somewhat before pelvic fins. Anus midway between appressed tips of pelvic fins and anal fin origin. Interorbital with a low longitudinal

ridge on each side near orbital margin and a low median hump in the center. Occiput convex, with a low median longitudinal keel; a single pair of ridges on each side are directed obliquely inward from the upper posterior margin of orbit; these ridges are covered over and do not form a trough or tube. Occiput posteriorly with one pore on the left and two pores on the right side penetrating the cranium. Anterior unossified prolongation on tip of lower jaw greatly reduced from the condition found in the smaller specimens. Premaxillary anteriorly with five fairly long depressible canines which are followed by 10 retrorse canines and 11 well developed antrorse canines. Mandible with approximately 12 well developed depressible canines and a greater number of fixed teeth in the outer row. Palatines anteriorly with two or three fairly long depressible canines followed by a single row of 12 short, fixed canines. Gillrakers rudimentary, one raker at posterior end of hypobranchial, 11 on ceratobranchial and several above angle on epibranchial. Pseudobranchiae consisting of nine tufts.

Lateral-line with 69 segments, terminating over middle of anal fin. The anterior sections are more than twice as high as long.

Dorsal rays 11. Anal rays 23. Pectoral rays 11. Pelvic rays 9, the fin situated at middle of body length.

Measurements in Percent. of Standard Length (All four specimens included; the mean is given first, followed by the range in parentheses). — Greatest body depth 6.8 (6.2-7.9); least depth of caudal peduncle 3.7 (3.5-4.2); length of caudal peduncle 29.2 (27.1-30.4); length of head 19.1 (18.2-21.4); length of snout 8.9 (8.3-9.9); eye diameter 4.3 (4.1-4.5); width of interorbital 3.1 (2.8-3.6); predorsal distance 68.1 (66.4-71.5); length of dorsal base 4.8 (4.5-5.5); distance between dorsal and pelvic fins 7.1 (5.8-8.5); dorsal to pelvic distance 7.1 (5.8-8.5); distance between a vertical from dorsal fin origin and anus 4.9 (4.5-5.8); preanal distance 81.1 (78.9-84.0); length of anal base 14.9 (14.1-15.5); length of pectoral fin 5.8 (4.7-6.5); length of pelvic fin 5.2 (4.9-6.0); prepelvic distance 60.0 (59.8-61.3).

Macroparalepis affine Ege.

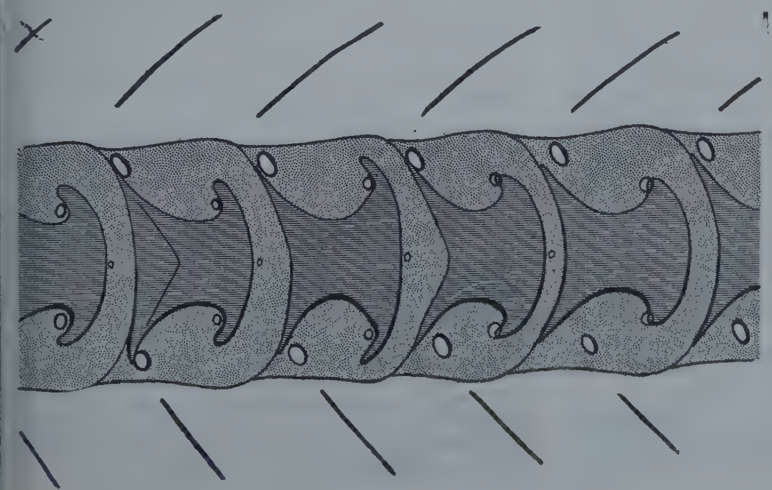
Material Examined. — One specimen, 128.5 mm. in standard length, from near Funchal, Madeira, from the stomach of *Alepisaurus ferox* Lowe (caught on tunny-hook at about 100 fathoms); originally Museu do Funchal no. 3005; now Stanford no. 15080; obtained from G. E. Maul.

Specimens Previously Recorded. — This species is known in the literature from nine specimens, 56.5-156 mm. in standard length, from off the north-west coast of Africa, described by Ege (1933, p. 231; holotype from south-west of Canary Islands) and Maul (1945, p. 28; eight specimens from off Madeira).

Description of Madeira Adult.—This specimen has been described and figured by Maul (1945), but additional notes are presented in the light of my own investigations.

Interorbital with numerous ridges. Occiput keeled and with six ridges on each side directed obliquely inward from upper posterior margin of orbit; all ridges covered over, and not leading into open tubes. Premaxillary anteriorly with three depressible canines followed by 38 fixed canines. Vomer toothless. Palatines anteriorly with five long depressible canines accompanied by short fixed teeth; posteriorly three large, widely spaced, retrorse canines. Last palatine tooth distinctly behind angle of gape. Tongue (glossohyal) with many teeth in two longitudinal series. Two teeth on first basibranchial. Gillrakers partially developed on first two arches. Each raker with two or three short teeth. Gillrakers on first arch comprising 15 on hypobranchial, 23 on ceratobranchial, and nine above angle on epibranchial. Gillrakers begin below anterior part of eye. Pharyngobranchial teeth reduced in number, confined to a single patch on each side. Pseudobranchiae well developed, consisting of 10 tufts.

Lateral-line with 87 sections, terminating slightly before a vertical from hind margin



TEXT-FIG. 7. Lateral-line of a specimen of *Macroparalepis brevis* Ege 98.3 mm. in standard length, illustrated in the same manner as figure C of the morphological drawings. This illustration is to be compared with figure 6C in order to show the changes that can take place in the lateral-line form between different growth stages. Except in *Sudis hyalina*, there is usually very little change in lateral-line form in the various growth stages of paralepids.

of anal fin. Each lateral-line section with double-concave center shields. Each anterior section contains two pores above and below. Most sections have a median pore.

Anus slightly behind pelvic fins which are below middle of dorsal fin.

This specimen is illustrated by Maul (1945) and in the generic review in press.

Macroparalepis danae Ege.

Specimens Taken by the Bermuda Oceanographic Expeditions.—Two specimens, 26.6 and 40.8 mm. in standard length; no 11,195; net 243; 600 fathoms; July 1, 1929; from a cylinder of water eight miles in diameter (five to thirteen miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.

Specimens Previously Recorded. — One adolescent 121 mm. in standard length, from south-west of Fiji Islands (20° 00′ S. Lat., 174° 29′ E. Long.), described by Ege (1933, p. 230).

Description of Bermuda Material. — The two Bermuda specimens are in poor condition, having dried out at one time. Despite the fact that the type was from near Fiji, these specimens agree quite well with Ege's description, for instance in the position of the pelvic fins far before a vertical from the dorsal fin, and similar counts and proportions. These two specimens are only tentatively identified with this species, and the record of this species from the Atlantic should be questioned until confirmed by other material.

Stemonosudis, New Genus.

Macroparalepis (in part) Ege, 1933, p. 229.

This genus comprises group II of *Macroparalepis* as delimited by Ege (1933). It is primarily characterized by (1) the presence of a foramen in the anterior process of the premaxillary, (2) upper jaw terminating approximately an orbital diameter before the anterior margin of the eye, (3) supramaxillary closely bound to maxillary, (4) teeth on lower jaw moderately developed, basally round, (5) gill-teeth reduced, subequal, in a single row, (6) body naked, (7) lateral-line sections approximately twice as long as deep, (8) dorsum of body not evenly pigmented, with saddle-like blotches, (9) anus situated in front of a vertical from dorsal fin. This genus is fully described in the generic review of the Paralepididae by the present author (in press).

Generic type *Stemonosudis intermedia* (Ege). It is presumed that *Macroparalepis macrura* Ege, *M. elegans* Ege, *M. elongata* Ege and *M. gracile* Ege belong to this genus, although I have been unable to examine any of them.

Stemonosudis intermedia (Ege).

Specimens Taken by the Bermuda Oceanographic Expeditions.—One adolescent, 125 mm. in standard length; original no. 13,101; now Stanford no. 15,356; net 423; 500 fathoms; Sept. 5, 1929; taken approximately at 32° 12′ N. Lat., 64° 36′ W. Long., off Nonsuch Island, Bermuda.

Specimens Previously Recorded. — One adolescent 144 mm. in standard length, from the Caribbean Sea (13° 47′ N. Lat., 61° 26′ W. Long.), described by Ege (1933, p. 235).

Description of Bermuda Adolescent.—Body eel-like, very elongate and thin; greatest depth at nape, 43.1 into standard length. No carinae. Caudal peduncle depth 9.0 into head; its length 2.8 into standard length. Anus a snout length before pelvic fins.

Head long and slender, slightly wider than body width, its length 7.7 into standard length. Snout very elongate, distinctly longer than remainder of head, its length 1.7 into head length. Nostrils distinctly behind a vertical from upper jaw. Eye very small, round, its diameter slightly greater than interorbital width, 9.0 into head length. Postorbital length one-half of snout length. Interorbital flat, with two pairs of high, compressed, longitudinal ridges, extending forward on snout; median pair terminates on interorbital; ridges of lateral pair diverge posteriorly, following upper orbital margin. Occiput with a pair of short ridges directed obliquely inward from the upper posterior margin of the eye; these ridges do not become roofed over, or enter tubes. Upper jaw length 2.2 into head length, terminating approximately one and one-half eye diameters before eye. Angle of gape at posterior tip of maxillary. Dentition very weakly developed. Premaxillary anteriorly with four closely spaced, depressible canines, followed by 28 fixed teeth. Mandible with fairly short canines in two series; fixed teeth on edge of jaw bone and depressible canines on inner face. Vomer toothless. Palatines anteriorly with four fixed teeth followed by two longer depressible canines, each accompanied by a short, fixed tooth; posteriorly, after a short gap, four widely spaced, fixed canines. Tongue (glossohyal) far forward, its tip an eye diameter before posterior end of upper jaw; no teeth on glossohyal or basibranchials. No gill-teeth or pharyngobranchial teeth yet developed. Pseudobranchiae consisting of seven tufts. Branchiostegal rays seven on both sides. The left branchial membrane overlaps the right.

Lateral-line tube with 92 sections, terminating over middle of anal fin. Every segment is twice as long as high and contains a double-concave center shield. Each segment has two pores above and below and generally a median pore.

Dorsal fin with 10 rays, its origin distinctly behind middle of body length. Dorsal fin approximately a head length behind the pelvic fin origin. Predorsal distance 1.6 into standard length. Anal rays 42. Length of anal base 4.9 into standard length. Pectoral fin rays 11 on both sides. Pelvic fin rays eight on both sides. Inner pelvic rays longer than outer rays. Principal caudal rays 9+10.

Coloration.—No mid-dorsal band, but only sparsely scattered chromatophores which are particularly concentrated in five saddle-like patches on back, starting at base of dorsal fin. These patches alternate with similar blotches above anal fin. A few scattered pigment cells on mid-ventral line. Otherwise no pigmentation on body. Head with scattered chromatophores on snout, lower jaw, suborbital, interorbital and occiput. Greatest pigmentation on head is a patch on top of middle of snout.

Measurements in Percent. of Standard Length. — Greatest body depth 2.3; least depth of caudal peduncle 1.4; length of caudal peduncle 35.7; length of head 13.0; length of snout 7.6; eye diameter 1.4; width of interorbital 1.3; predorsal distance 64.7; length of dorsal base 1.8; dorsal to pelvic distance 10.5; distance between a vertical from dorsal fin and anus 19.4; preanal distance 76.3; length of anal base 20.2; length of pectoral fin 5.3; length of pelvic fin 3.0; prepelvic distance 53.9.

This form is illustrated in the generic review in press.

Genus **Sudis** Rafinesque.

The genus *Sudis* is primarily characterized by (1) the lack of any foramen in the anterior process of the premaxillary, (2) upper jaw terminating somewhat before a vertical from anterior border of eye, (3) supramaxillary closely bound or fused to maxillary, (4) teeth on lower jaw well developed, triangular, with serrate edges, (5) gill-teeth reduced, subequal, in a single row, (6) head scaled on preoperculum; otherwise head and body lacking scales.

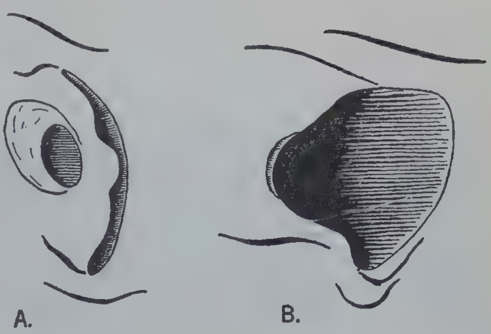
This genus includes only a single species known from the Mediterranean and off Madeira. The Bermuda Expeditions did not collect this genus.

Sudis hyalina Rafinesque.

Text-figs. 8 & 9.

Material Examined. — Three specimens 125.9-320 mm. in standard length, from the Mediterranean and off Madeira.

Specimens Previously Recorded.—Apparently only a few specimens (about 25) of this supposedly well-known species have been recorded in the literature, and most of the accounts of this form were published about the middle of the 19th century. I have been unable to see all the references concerning *Sudis hyalina* because a considerable portion of the early Italian literature by Verany, Costa, Bellotti, Cocco and Doderlein was unavailable. Unfortunately none of the recent papers mentioning *Sudis hyalina* (Ege, 1930; Maul, 1945; and Parr, 1928) have included an adequate survey of the literature on this species. Apparently the only 20th century paper describing adults is by Maul (1945, p. 34). The only paper on the early growth stages is by Sanzo (1917). The best 19th century descriptions and figures appear to be those of Bonaparte (1832-41), Cocco

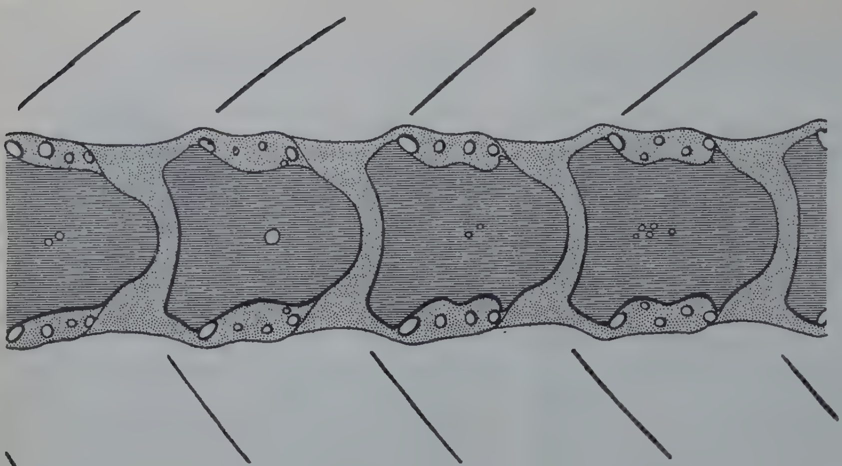


TEXT-FIG. 8. Nostrils of *Sudis hyalina* Rafinesque. The head is facing left. **A.** Anterior and posterior nostril of a specimen 125.9 mm. in standard length. **B.** Nostrils of a specimen 300 mm. in standard length; the anterior nostril is reduced to a small slit in the front border of the posterior nostril.

(1839) and Costa. Canestrini (1872, p. 127) records *Sudis hyalina* from Sicilia, Napoletano and Liguria. Carus (1893, p. 567) mentions it from Nizza, Genova, Napoli, Catania and Calabria.

Since specimens of *Sudis hyalina* are particularly rare in museums, it is of interest to record what I have learned about the distribution of preserved material. Apparently there are no representatives in New World institutions except those used for the present study at Stanford University. These were recently obtained from the H. H. Giglioli collection mentioned below. Dr. Ethelwynn Trewavas has informed me that the British Museum (Natural History) has two specimens. Mr. G. E. Maul presented them with a large adult which the British Museum kindly lent me for the present study. Maul has written me that he has only one specimen at Madeira now. Dr. Enrico Tortonese very graciously checked numerous Italian museums for examples of *Sudis hyalina* and obtained interesting results. The Instituto e Museo di Zoologia of the University of Torino has but one large adult from Naples, Italy. The Genoa Museum, which has the largest ichthyological collection now existing in Italy, has only one specimen from the Ligurian Sea. The small fish collection of the Statione Zoologica di Napoli has six specimens, including a large adult. The Museo di Storia Naturale di Firenze probably has the largest existing series of this form, which was assembled many years ago by the late H. H. Giglioli. There is one adult from Palermo, Sicily, two adults and five juveniles from Messina, Sicily, four specimens from Catania, Sicily, and two adults from Naples, Italy. Dr. Tortonese also found mention in Giglioli's manuscript notes of specimens in the small museums of the Universities of Catania and Palermo, and that a specimen from Naples was preserved in Bellotti's collection (Museum of Milano) which was destroyed during the last world war.

Description of Mediterranean Subadult of 125.9 mm.—Interorbital convex with a



TEXT-FIG. 9. Lateral-line of a specimen of *Sudis hyalina* Rafinesque 125.9 mm. in standard length, illustrated in the same manner as figure C of the morphological drawings.

median longitudinal depression parallelled on each side by a single low closed tube; interorbital lacking ridges. Occiput slightly concave, with two pairs of ridges on each side (but not open and leading into tubes) directed obliquely inward from the upper margin of the orbit. Surface of these covered tubes is pierced by numerous pores. Premaxillary anteriorly with one tiny depressible tooth followed by 11 minute teeth which insensibly grade into a rough-edged premaxillary. Tip of lower jaw without anterior unossified prolongations. Vomer toothless. Palatines anteriorly with one fairly short fixed tooth followed by a longer depressible canine. Palatine teeth near tip of snout. Tongue toothless. Mandible anteriorly with two tiny, retrorse canines near tip of jaw; behind these are five large, fixed, antrorse canines; these teeth are broad and flattened and have serrate anterior and posterior margins. On each side of snout are two nostrils separated by a thin membrane; the anterior nostril is smaller, in a short posteriorly directed tube. Gillrakers partially developed; each raker consisting of a small base with two short spines. Gillrakers on first arch nine on hyopchanchial, 25 on ceratobranchial, and eight above angle on epibranchial. Gillrakers begin below anterior part of eye. Pharyngobranchial teeth in one oval patch on each side.

Lateral-line with 63 sections, terminating behind anal fin near the beginning of the procurrent caudal rays. Each anterior lateral-line segment with an elongate center shield that has slight indentations. Each anterior section contains 4-5 pores above and below the center shield; in last segments there are one or two pores above and below; rarely is there a median pore. True scales developed on preoperculum in two series. Othewise body and head naked.

Pectoral fins as long as distance from snout tip to preopercular margin. Pelvic fins with outer rays distinctly longer than inner rays.

Description of Mediterranean and Madeira Adults of 300 *and* 320 *mm.*—Except where indicated as otherwise, these specimens agree with the description of the subadult presented above.

The ridges on the occiput lead into two tubes on each side, instead of being closed as in the subadult. Edge of premaxillary finely serrate, without anterior depressible canines. Mandible with two tiny teeth near tip of lower jaw, followed by eight fixed teeth. On the inside of the fixed teeth is another series of partially formed teeth, which are depressible and pointing obliquely inward and posteriorly. Palatines anteriorly with a single fairly large fixed tooth followed by 2-3 larger depressible canines; posteriorly 12-14 tiny retrorse fixed canines in a single row; all of these palatine teeth basally round. On each side of snout is a single large nostril; in the anterior border of this nostril is a minute anterior nostril. Gill-teeth developed on first two arches only; each raker with two short spines. Gillrakers on first arch 21-23 on hypobranchial, 24 on ceratobranchial, 9-11 above angle on epibranchial. Gillrakers begin midway between eye and upper jaw.

Lateral-line with 71-75 sections, extending onto hypural fan. Each lateral-line segment with circular overlapping scale-like shields, which are pierced by pores above and below.

Pectoral fins as long as snout.

The 300 mm. specimen is figured by Maul (1945) and in the generic review in press.

Discussion of Relationships.—While the above specimens, approximately one foot long, are large for paralepids, the incomplete development of the gill-teeth probably indicates that these specimens are not fully grown. Most of the so-called adult specimens of the scaled genera and of many of the naked genera also do not appear to be fully grown, and it is probable that the true adults are so swift that they have evaded collectors' efforts to catch them.

Sudis hyalina is the most unusual paralepid known, and it is difficult to trace its relationships. The presence of only a few weakly developed scales on the preoperculum would superficially place it in an intermediate position between the scaly and naked

genera of the family. The dentition of the premaxillary is very much like that of the most primitive scaly genus in the family (new genus, in press). The gillraker form, distribution of pharyngobranchial teeth, lack of body squamation, general body and particularly head form, and lateral-line form is clearly the same in many respects as in *Lestidium* and the other naked genera. *Sudis* is different from all other paralepids in many respects. So far as known it is the only paralepid (1) without a foramen in the anterior process of the premaxillary, (2) with the anterior nostril vestigial in the adult, (3) with broad, flattened, mandibular teeth, (4) with serrate teeth, (5) with the greatly enlarged teeth in the lower jaw fixed, (6) with enlarged pectoral fins, (7) with the outer rays of the pelvic fins longer than the inner rays, and (8) with the supramaxillary fused to the maxillary in the adult. It is expected that further study of the osteology of this form will reveal more of its relationships and differences. On the basis of our present knowledge it seems that *Sudis* must have split off early from the remainder of the family and followed in many respects the evolutionary pattern of the naked genera of the subfamily Paralepidinae.

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3.

Miscellaneous Notes on the Eggs and Young of Texan and Mexican Reptiles.

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(Plates I-VII).

Scarcely any field work has been done on the habits of Mexican reptiles, and even the mode of reproduction (whether oviparity or ovoviviparity) of only a very few is known with certainty. For example, no information on breeding habits is available in Smith (1939) for 63 of the 80 forms of *Sceloporus* listed by him as occurring in Mexico. Other illustrations are frequent. In view of this general lack of information, the following notes, although fragmentary, may be of some value.

Opportunities for collecting Mexican reptiles during 1949 and 1950 and subsequently returning these alive to the San Antonio Zoo for observation, resulted in an accumulation of miscellaneous notes on the breeding habits of various snakes and lizards of Mexico. A few supplementary notes are from observations of snakes purchased from dealers.

In addition, considerable information on the eggs and young of some Texan reptiles has been mustered, mostly from material collected by me, but also from specimens donated to the Zoo by local people.

Of particular interest are the records of eggs and young about which nothing has been recorded previously. These records, i.e., *Coleonyx brevis, Crotaphytus reticulatus, Sceloporus grammicus microlepidotus, Eumeces brevilineatus, Eumeces tetragrammus, Abronia taeniata graminea, Heterodon nasicus kennerlyi, Masticophis m. mentovarius* and *Trimorphodon biscutatus semirutus*, whenever possible, are accompanied by a brief description of the hatchlings or newborn snakes.

The larger snakes were kept in regular zoo exhibition cages while the smaller snakes and all the lizards were confined individually in gallon glass jars covered with screen lids. Eggs were incubated in Pyrex dishes partially filled with damp sand, and this medium was covered with a dampened paper hand towel upon which the eggs were placed. Moisture within the containers was controlled by placing a glass lid over each dish, which could be moved aside to permit excess moisture to escape, and replaced when it was desired to retain moisture. Prevailing temperatures during incubation varied from 70 to 90 degrees Fahrenheit.

All measurements, recorded in millimeters and arranged in order of increasing length, were taken as soon as possible after laying, hatching, or birth of young—usually on the same day.

Richard Friedrich, President of the San Antonio Zoological Society, and Fred Stark, San Antonio Zoo Director, kindly made possible the time for numerous collecting trips without which many of the specimens would not have been procured. For several local specimens I am indebted to Jack Ried and Glen Fry, both of San Antonio, and Ralph Axtell, of Bishop, Texas.

Coleonyx brevis Stejneger.

Smith (1946) says of this species, "The life history . . . is unknown. Presumably eggs are laid."

Two females from 15 miles north of San Ygnacio, Texas, laid eggs on April 8, 1950, but none hatched. The egg shells were smooth and white.

I. Female measured: total length, 107 mm.; tail, 46 mm.

No.	*Length*	*Width*
1	15	8
2	16	9
Average	15.5	8.5

II. One egg was laid by a female of undetermined length.

No.	*Length*	*Width*
1	17	8

Crotaphytus reticulatus Baird.

No information is available in the literature on the number or size of the eggs laid by this form. Smith (1946) states it is one of the least known lizards of the country and that its life history is practically unknown.

A female collected in Starr County, Texas, on June 1, 1950, was obviously gravid when caught, the outlines of the eggs being very pronounced against the body wall. The lizard died of undetermined causes on January 24, before oviposition could take place, and dissection disclosed 8 well-developed eggs, almost spherical in shape.

No.	*Length*	*Width*
1	10	9
2	13	13
3	14	14
4	15	13
5	15	13
6	15	13
7	15	14
8	16	14
	Average 14.1	12.8

Sceloporus variabilis variabilis Wiegmann.

A female from near Las Vigas, Veracruz, (elevation 7,500 feet), died at the Zoo on February 11, 1950. Dissection revealed 7 developing embryos, partially enclosed in yolk sacs. They had clearly defined patterns similar to that of the female.

No.	*Total length*
1	25
2	25
3	26
4	26
5	26
6	27
7	28
	Average 26.1

Sceloporus grammicus microlepidotus Wiegmann.

Smith (1939) says of this race, "As recorded by Herrera, Gadow, and others, *m. microlepidotus* (= *grammicus microlepidotus*) is ovoviviparous." This apparently is the extent of information available on the young.

Seven gravid females were collected in an area of volcanic rock, 3 miles east of Las Vigas, Veracruz, Mexico, January 15 and 16, 1950. Elevation at this site is 7,500 feet.

I. A female, 127 mm. in total length, with a tail 59 mm. long, gave birth to 7 young during the night of January 11, 1950.

No.	*Total length*	*Tail length*
1	51	29
2	52	28
3	52	29
4	52	30
5	53	29
6	53	30
7	53	31
	Average 52.2	29.4

The young of this and the following broods of *microlepidotus* are much alike in pattern and color, the only important variation being a shortening of the wavy, transverse bands in some specimens or their almost complete absence in others, resulting in a pattern of small, paired dorsal spots.

The living young are described as follows:

All have a velvety appearance. Dorsum gray to dark brown, stippled with darker and lighter flecks which become more pronounced laterally. Five to 7 dark brown or black transverse dorsal bands; tail bands 14 to 19, averaging 18. The gular fan is erect and quite pronounced in some individuals, even in those not excited. However, the brilliant color characteristic of the fan in adult males, is lacking. Superciliaries black, banded with pale yellow; these bands being half as wide as the black spaces between them. Lower eyelids black.

A narrow, dark line, in the form of an obtuse angle, begins at the anterior edge of the median frontonasal, the arms reaching the posterior edges of the outer frontonasals. A similar but shorter line behind this one. Two narrow, irregular postocular dark stripes extend slightly downward from the orbit, through the ear opening, and unite with the nuchal collar. Another narrow, dark line extends upward and backward from the orbit. Upper and lower labials with a yellowish-orange tinge.

Black nuchal collar edged on either side with pale yellow. Beginning on front of shoulders, it continues uninterrupted across nape, or, more rarely, is separated mid-dorsally by several scale rows. Posterior edge of collar regular; anterior, irregular. In some specimens the nuchal collar is interrupted mid-dorsally by several small, irregular, black spots. A light pineal spot is present in most individuals.

Dorsal color of limbs same as that of body above, and marked with indistinct, narrow, black bands. Ventrum and underside of limbs dark metallic-green and immaculate.

II. This female, 145 mm. long, gave birth to 5 young on February 25, 1950.

No.	*Total length*	*Tail length*
1	54	29
2	56	26
3	57	22
4	57	33
5	57	34
	Average 56.4	28.8

III. A female with a total length of 116 mm. gave birth to 5 young on February 12, 1950, between 10:00 a.m. and 2:31 p.m.

No.	*Total length*	*Tail length*
1	56	33
2	57	33
3	59	34
4	60	36
5	62	38
	Average 58.8	34.8

IV. Seven young were born on February 7, 1950, to a female 114 mm. long.

No.	Total length	Tail length
1	46	20
2	46	21
3	47	21
4	48	22
5	50	22
6	50	23
7	51	23
	Average 48.2	21.7

V. A female, 126 mm. in length, gave birth to 5 young on February 18, 1950.

No.	Total length	Tail length
1	53	24
2	53	24
3	55	24
4	56	23
5	57	26
	Average 55.8	24.2

VI. Four young were born on February 16, 1950, to a female 117 mm. long.

No.	Total length	Tail length
1	47	21
2	48	22
3	50	22
4	51	23
	Average 49.0	22.0

VII. Seven young were born on March 6, 1950, to a female measuring 146 mm.

No.	Total length	Tail length
1	54	28
2	55	29
3	55	30
4	55	31
5	56	28
6	57	31
7	58	34
	Average 55.7	30.1

The young were quite active soon after birth, crawling over and under the leaves in their cages and climbing to the tops of limbs, where they remained sometimes for hours. Their ability to leap from the cage floor to half-way up to a twelve-inch limb was a most amazing feat. Small ants and fly larvae were offered as food a week after birth of the lizards, and although the ants were pursued and eaten, the larvae were rejected after a cursory examination.

Sceloporus torquatus torquatus Wiegmann.

A large female collected by Miss Juanita Krackowitzer in the Mexican state of Michoacan, near Morelia, gave birth to 6 young on May 8, 1950.

No.	Total length	Tail length
1	70	39
2	70	40
3	70	41
4	71	39
5	71	39
6	71	40
	Average 70.4	39.6

The young are described as follows:

Ground color dark gray. Head gray except for an area of dull bronze on the frontal and a small, dark green spot on the anterior portion of the interparietal. A few small, black specks widely scattered over the head. Side of head becoming gradually lighter behind eye, but light area below canthus rostralis sharply contrasting with darker color above. Upper palpebrals bluish-green, edged with black; lower palpebrals similar but with more black. Chin gray, suffused with bluish-green. Dark blue, uninterrupted nuchal collar, somewhat lighter mid-dorsally, 3 to 3½ scales wide. Collar with white posterior edge, except mid-dorsally; anterior edge white.

Five pairs of indistinct, dark spots along back. A lateral series of smaller dark spots. Tail with 16-18 dark gray bands, 2 or 3 scales wide, becoming indistinct ventrally. Legs and digits with dark gray bands above, similar to those on tail. Ventrum light gray, suffused with greenish-blue.

Leiolopisma laterale (Say).

The egg-laying period of this species as noted by Smith (1946), extends from early June to early August.

Four females collected by Lester Ellsworth at San Marcos, Texas, laid eggs at the San Antonio Zoo during April and early May, 1950.

I. This female laid 4 eggs on April 19.

No.	Length	Width
1	8	4
2	9	4
3	9	4
4	9	5
	Average 8.7	4.2

II. A female, 38 mm. long, laid 2 eggs on April 27.

No.	Length	Width
1	8	3
2	9	4
	Average 8.5	3.5

III. Three eggs were deposited by a large female on April 29.

No.	Length	Width
1	9	4
2	9	4
3	9	5
	Average 9.0	4.3

IV. On May 1, a female laid 2 eggs.

No.	Length	Width
1	9	4
2	9	5
	—	—
	Average 9.0	4.5

Eumeces lynxe furcirostris (Cope).

Two adult females were collected 3 miles east of Las Vigas, Veracruz, Mexico, January 16, 1950.

I. This lizard gave birth to 5 young on March 12, 1950. Total length of female, 124 mm.

No.	Total length	Tail length
1	50	24
2	51	25
3	52	25
4	54	25
5	55	27
	—	—
	Average 52.4	25.2

II. On March 17, 1950, 3 young were born to a female 134 mm. long.

No.	Total length	Tail length
1	47	23
2	54	24
3	57	26
	—	—
	Average 52.6	24.3

Eumeces brevilineatus Cope.

Smith (1946) states that the life history of this lizard is not known.

On April 13, 1949, a large female, measuring 182 mm. in total length, was collected under old papers on Somerset Road, just south of San Antonio, Texas. On May 18, thirty-five days after capture, the lizard laid 7 non-granular, non-adhesive eggs, the first of a complement of 12. The following day another egg was deposited, and subsequently, on May 20, four additional eggs were laid. Three of these, which were soft and buff-colored, soon desiccated.

No.	Length	Width
1	10	7
2	10	7
3	11	8
4	11	8
5	12	6
6	12	7
7	12	8
8	12	8
9	12	8
10	12	8
11	12	8
12	12	8
	—	—
	Average 11.5	7.5

With apparently good reason, the female made no attempt to bury the eggs or to cover them with the slightly damp sand upon which they were deposited. Taylor (1935) notes that the eggs laid by captive *Eumeces s. septentrionalis* invariably rotted if completely covered by moist earth.

Although on several occasions the lizard was found coiled loosely about the eggs for short periods, this behavior was not consistent and therefore does not seem sufficient evidence that bodily incubation of the eggs is normal for this species.

Three of the eggs hatched, the others having desiccated during incubation. Two young emerged from their shells on the morning of June 13, between 8:05 a.m. and 8:14 a.m.; the third on the morning of June 14.

No.	Total length	Tail length
1	49	24
2	51	25
3	53	26
	—	—
	Average 51.0	25.0

The young are considerably darker than the parent. Dorsal ground color is deep chocolate brown, each scale with a light posterior edge. Sharply defined cream colored dorsolateral lines extend backward from tip of snout, passing above nostrils and across supraoculars, and disappearing well behind axilla. Union of the dorsolateral light lines on the snout results in a light, vertical bar through the rostral. Well defined lateral lines extend backward from rostral, the same distance as dorsolateral lines.

Chin and throat light brown and immaculate. Ventrum light brown anteriorly, becoming gradually darker posteriorly. Tail above chocolate brown at base, rapidly becoming light green posteriorly. Posterior three-quarters of tail azure blue. Fore-legs uniformly dark brown above; immaculate and dirty white beneath. Hind legs uniformly dark brown above and but little lighter below.

Eumeces tetragrammus Baird.

Two females laid eggs at the Zoo during 1950.

I. Twelve eggs were laid on the morning of April 27, 1950, by a large female collected at the northern outskirts of Laredo, Texas.

No.	Length	Width
1	7	12
2	9	7
3	10	6
4	10	7
5	10	7
6	10	7
7	10	8
8	11	7
9	11	7
10	11	7
11	11	7
12	12	7
	—	—
	Average 10.2	7.4

II. Another female from the same locality as the first, laid 5 eggs on May 4, 1950.

No.	*Length*	*Width*
1	12	6
2	12	7
3	13	8
4	14	7
5	14	8
	—	—
Average	13.0	7.2

Abronia taeniata graminea (Cope).

Smith (in letter) states there is absolutely nothing known regarding the breeding habits and life history of this species.

Many individuals of the species *taeniata* found in the Las Vigas area of Veracruz appear to be intergrades between the races *taeniata* and *graminea*. Our specimens exhibit characteristics of both forms, although they favor the latter.

A large female from 3 miles east of Las Vigas, Veracruz, Mexico, gave birth to 4 young on April 12, 1950.

No.	*Total length*	*Tail length*
1	67	36
2	72	39
3	74	40
4	76	41
	—	—
Average	72.2	39.0

The young are described as follows:

Top of head bluish-green, lightly flecked with black. A postocular black marking on either side of head, directed backward and upward to the tertiary temporals, thence narrowing as it extends forward from these scales, along the outer edges of the supraoculars. An irregular, small, black parietal spot near back of the head. Immediately behind this, extending laterally, are two large, black spots. A narrow, black line extends in an arc from below the eye to the loreal. Below this is a somewhat wider postocular black stripe from behind the eye to the ear opening. Lower edges of upper labials irregularly edged with black.

A series of 9 irregular, black crossbands on body, 19 on tail; those near end of tail reduced to mere spots. Ground color on back, light tan or dirty-white. A series of somewhat diffused secondary lateral spots extending onto edge of ventrum. Limbs banded above with black. Soles of feet a pale greenish-yellow. Ventrum immaculate and dirty-yellow.

In two specimens the crossbands are shortened and interrupted mid-dorsally, resulting in a pattern of small, paired spots, irregular and variable in shape (Pl. II, Fig. 5).

Gerrhonotus liocephalus infernalis Baird.

I. A female from Medina County, Texas, laid 3 eggs between 3:02 p.m. and 6:30 p.m. on January 30, 1950; two more between 6:15 p.m. and 6:30 p.m. on January 31; and 5 more on February 1. The eggs were white, non-granular and non-adhesive.

No.	*Length*	*Width*
1	15	9
2	16	9
3	16	10
4	16	10
5	17	9
6	17	11
7	17	13
8	18	9
9	18	10
10	19	9
	—	—
Average	16.9	9.9

II. A female from central Texas laid 5 eggs under a piece of bark in her cage on February 18, 1950. These were white, non-granular and non-adhesive.

No.	*Length*	*Width*
1	19	10
2	19	10
3	19	11
4	19	11
5	20	10
	—	—
Average	19.2	10.4

During incubation, 2 of the eggs became moldly and were discarded. Egg slits were seen to appear in 2 of the remaining eggs on the morning of March 31, and in the last egg about noon of April 1. By 1:00 p.m., April 2, all the lizards had emerged from their shells.

No.	*Total length*	*Tail length*
1	90	34
2	95	35
3	99	36
	—	—
Average	94.6	35.0

Heterodon nasicus kennerlyi Kennicott.

Seven eggs were found in a sack containing a female brought to the Zoo on June 3, 1950. The snake, which measured 656 mm. in total length and 76 mm. in tail length, was collected in Starr County, Texas. The eggs were white, smooth and non-adherent. They were beginning to desiccate when discovered and failed to hatch.

No.	*Length*	*Width*
1	20	15
2	22	14
3	22	15
4	23	14
5	23	15
6	24	14
7	24	15
	—	—
Average	22.5	14.5

Masticophis flagellum testaceus (Say).

A female from San Antonio, Texas, measuring 1,324 mm., laid 8 eggs on June 6, 1950. These were white and granular.

No.	Length	Width
1	40	22
2	44	22
3	45	22
4	46	23
5	46	23
6	49	22
7	51	25
8	57	24
	—	—
	Average 47.2	22.9

Masticophis mentovarius mentovarius (Dumeril & Bibron).

Ortenburger (1928) gives no information concerning the eggs of this form, nor are data on its breeding habits available elsewhere in the literature.

A large female collected on January 15, 1950, several miles north of Alvarado, Veracruz, Mexico, deposited 17 eggs between March 23 and 25, 1950. These were white, non-adhesive, and covered with fine, salt-like grains (Pl. V, Fig. 11). Three were discovered on the cage floor on the morning of March 23, and 9 were laid that day at intervals of 39 to 72 minutes, with an average between ovipositions of 51 minutes. Three additional eggs were found in the cage on the morning of March 24, and 2 more the following morning, March 25. Desiccation of the eggs apparently took place during an attempt to photograph them under hot photoflood lights. In spite of subsequent efforts to save them by the use of additional moisture, they soon dried beyond recovery.

No.	Length	Width	Weight (in grams)
1	46	30	26.6
2	48	30	24.0
3	51	30	24.7
4	51	31	24.0
5	51	33	24.5
6	52	32	23.3
7	54	32	25.9
8	54	34	24.7
9	55	29	26.6
10	55	31	26.5
11	57	26	22.3
12	58	31	24.9
13	58	32	26.2
14	61	29	26.9
15	61	30	26.4
16	61	32	26.9
17	64	30	25.9
	—	—	—
	Average 55.1	30.7	25.3

Drymobius margaritiferus margaritiferus (Schlegel).

A female, 940 mm. long, laid 2 infertile eggs on July 29, 1950. These had non-adhesive, non-granular shells.

No.	Length	Width
1	43	15
2	45	14
	—	—
	Average 44.0	14.5

Elaphe laeta laeta (Baird & Girard).

On June 14, 1950, a female 1,136 mm. long, from near Brownsville, Texas, laid 5 smooth, adhesive eggs. Ten more were deposited the following day, June 15.

No.	Length	Width
1	40	29
2	41	30
3	42	27
4	43	28
5	43	28
6	44	29
7	45	28
8	45	29
9	45	30
10	46	29
11	46	29
12	46	30
13	47	28
14	47	31
15	50	30
	—	—
	Average 44.6	29.0

Slits first appeared in 2 of the eggs on August 7, and these snakes emerged from their shells on August 8. Two additional snakes escaped from their shells on August 9, another on August 10, and the last two on August 12.

No.	Length	Width
1	370	63
2	377	68
3	377	69
4	380	65
5	395	65
6	397	66
7	397	67
	—	—
	Average 384.7	66.1

Examined several days after hatching, the young may be described as follows:

Dorsal ground color very light brown. The dorsal body blotches, which number from 33 to 36 and show an average of 35, have a chestnut brown color and are from 4 to 6 scales long and 8 to 12 scales wide. Each blotch bears a dark brown border, ½ scale wide; more distinct on the anterior and posterior than on the lateral edges. Dorsal tail blotches 22 to 26. A series of lighter colored lateral blotches below and alternating with the dorsal series, being regular in size and shape. Small dark brown spots, irregular in size and shape, below the secondary blotches, extending from the third and fourth rows of scales to the lateral edges of the ventrals.

Ventrum pale pink and marked with many small, rectangular spots which tend to group in pairs and generally are more numerous along the outer edges of the ventrals.

Snout, from top of rostral to anterior edge of prefrontals, olive brown. A dark, U-shaped interocular stripe extends across posterior portions of prefrontals, anterior edge of frontal, anterior portions of supraoculars, and upper part of preoculars. A postocular stripe of similar color begins directly behind orbit, terminating on the seventh and

eighth, or eighth and ninth upper labials. A dark brown subocular spot occupies portions of fourth, fifth and sixth upper labials. Additional small, brown spots on the lower halves of first, second and third upper labials.

The first nuchal blotch separates near the back of the head; the two attenuated halves continuing forward as two arms of a pincer through the middle outer edges of the parietals, to the posterior third of the frontal. A small, brown spot, usually round, covers the center of the frontal. Small, irregular, brown spots on the outer edges of the mental and along sutures of the lower labials. Remainder of chin and throat immaculate.

Elaphe obsoleta confinis Baird & Girard.

I. A small female, 762 mm. in length, collected by Jack Ried at Los Olmos Dam, San Antonio, Texas, deposited 5 eggs on June 24, 1949. These white, non-granular eggs were found in a shallow depression in the sand which covered the cage floor, the excavation apparently having been made by the female before or during egg laying.

No.	*Length*	*Width*
1	67	18
2	67	21
3	70	19
4	71	20
5	76	20
Average	70.2	19.6

Slits were seen to appear in one egg of the clutch on August 15. This snake emerged from its shell on August 16. The remaining 4 eggs hatched on August 17.

No.	*Total length*	*Tail length*
1	418	68
2	419	64
3	431	70
4	448	78
5	447	76
Average	432.6	71.2

II. On July 19, 1950, fourteen eggs were found by Jack Ried near San Antonio, Texas, in the top of a rotted, standing tree trunk, over 5 feet above the ground. Egg shells of a previous hatching, probably last year's, were found with the live eggs.

No.	*Length*	*Width*
1	43	28
2	43	30
3	43	30
4	43	31
5	43	32
6	44	29
7	44	30
8	45	31
9	46	29
10	46	30
11	46	31
12	46	31
13	46	32
14	47	31
Average	44.6	30.3

The eggs hatched on July 27, 28 and 29.

No.	*Total length*	*Tail length*
1	387	69
2	396	65
3	413	77
4	413	79
5	415	71
6	437	79
7	441	68
8	442	77
9	455	79
10	457	75
11	457	81
12	500	76
13	501	80
14	510	84
Average	444.5	75.7

A comparison of the pattern of these young with that of a Florida *confinis* now at hand, apparently also recently hatched, is interesting in view of the current uncertain status of the western population, formerly called *lindheimeri* and later placed in synonymy with *confinis*.

Adult Texan *confinis*, as a group, are extremely variable in both pattern and coloration, even within a small geographic area, but all of the 45 or 50 young examined thus far (this group included) have been consistently similar in these characteristics.

The juvenile Florida *confinis*, received from E. Ross Allen and collected at Wakulla Springs in Wakulla County, is readily distinguishable from young Texan specimens by (1) the smaller dorsal blotches and (2) the wider intervening spaces separating them.

A typical juvenile from Texas (No. 2, above) has 33 dorsal blotches on the body and 15 caudal blotches, those on the body being from 3 to 5 scales long (average 4.5) and from 10 to 13 scales wide (average 12). The spaces between blotches are from 2 to 3.5 scales long (average 2.5). The Wakulla Springs specimen measures 332 mm. in length and possesses 30 dorsal body blotches and 15 tail blotches. In comparison with the Texan young, it has body blotches which are from 3 to 5 scales long (average 4.5) and from 7 to 9 scales wide (average 8.5). Spaces between blotches vary in length from 3 to 7 scales (average 4).

Other conspicuous differences are the proportionately much smaller lateral blotches of the Wakulla Springs young and the lighter, almost white, ground color of this specimen as compared with the light gray ground color of the Texan young.

An adequate series of young from the eastern part of the range is necessary before these differences can be proved consistent.

III. A 1,374 mm. long female from several miles north of Junction, Texas, laid 7 eggs on June 19, 1950.

No.	Length	Width
1	61	26
2	63	25
3	65	24
4	65	27
5	66	24
6	70	25
7	71	26
	—	—
	Average 65.8	25.3

Three of these hatched on August 7.

No.	Total length	Tail length
1	443	73
2	451	75
3	463	78
	——	—
	Average 452.3	75.3

IV. A female caught on the grounds of Incarnate Word College, San Antonio, Texas, laid 1 egg on June 13, 1950, 2 eggs on June 15 and 6 on June 16.

No.	Length	Width
1	41	22
2	41	23
3	42	23
4	42	24
5	44	24
6	44	24
7	45	24
8	45	25
9	47	23
	—	—
	Average 43.4	23.5

One of these eggs hatched on August 8; four on August 9.

No.	Total length	Tail length
1	227	47
2	415	65
3	428	66
4	431	69
5	442	72
	——	—
	Average (of 4) 424.0	64.0

Hatchling No. 1 is an aberrant runt with a pattern of well-defined longitudinal stripes (Pl. VI, Fig. 14), and is described as follows:

Dorsal ground color gray, tinged with yellow mid-dorsally. The center of each scale with more or less dense, black pigment; the posterior edge dirty-white. Two black dorsal stripes, 2½ scales wide, beginning near the parietals and terminating at the tip of the tail. A narrow lateral line on either side of the dorsal stripes, beginning on the neck (where they are 2.5 scales wide), decreasing gradually in width, and terminating at a point several inches from the head (where they are a half scale wide). Many narrow, black, longitudinal streaks dorsally and laterally, becoming more numerous along the sides. These are generally from 3 to 5 scales long. A black spot on the outer edge of each ventral scale, forming a broken line from the third ventral to the tip of the tail. Ventrum with a suffusion of dark pigment.

Top of head gray. Snout somewhat darker than remainder of head. An interocular black stripe crosses the posterior halves of the prefrontals, the extreme anterior edge of the frontal, and sutures of the supraoculars and prefrontals. An irregular, transverse, dark mark across the middle of the frontal. Postocular dark stripe from orbit to seventh and eighth upper labials. Posterior edges of upper and most of lower labials with some black marking.

Lampropeltis getulus splendida (Baird & Girard).

During the night of July 24, 1950, a female from Christine, Texas, deposited 12 eggs in the water dish in its cage, but as a result of lying in the water for many hours before discovery, the eggs became hard and turgid and failed to hatch. The following measurements, therefore, must be considered abnormally large and probably out of true proportion, since the water-soaked eggs undoubtedly lost their true shape and likely increased somewhat in size during submergence.

No.	Length	Width
1	35	19
2	35	20
3	35	20
4	36	20
5	36	22
6	36	22
7	37	23
8	38	25
9	39	24
10	39	25
11	40	26
12	41	30
	—	—
	Average 38.1	23.0

Lampropeltis doliata annulata Kennicott.

On May 28, 1949, a female of this subspecies was collected at Christine, Texas. The snake measured 712 mm. in total length. Between 10:00 a.m. and 4:23 p.m., June 5, the snake laid 5 eggs with smooth, adhesive shells.

No.	Length	Width
1	48	18
2	48	19
3	49	20
4	49	21
5	52	20
	—	—
	Average 49.2	19.6

Two days before hatching, the eggs appeared somewhat collapsed, and on July 24, fifty days after oviposition, slits appeared in 2 of the eggs. The following morning 2 hatchlings were found coiled on the floor of the incubation dish, and during the afternoon a third hatched.

No.	Total length	Tail length
1	231	34
2	234	35
3	237	36
Average	234.0	35.0

Natrix sipedon confluens Blanchard.

A large female, 715 mm. long, collected by Lawrence Curtis in central Texas, was confined for 16 months with a smaller, almost totally black male from Louisiana. On the morning of July 25, 1950, ten new-born young were found in the cage. All were light in color and vividly marked.

No.	Total length	Tail length
1	176	26
2	209	54
3	213	51
4	220	54
5	221	58
6	225	54
7	225	60
8	230	55
9	234	57
10	239	60
Average	219.2	52.9

Thamnophis marcianus marcianus (Baird & Girard).

Two females collected at Helotes, Texas, gave birth to young during 1950. The young of the first brood all had mid-dorsal stripes of pale yellow while those of the second brood possessed stripes of pale orange.

I. Eleven young were born on June 19 to a female 676 mm. long.

No.	Total length
1	175
2	179
3	180
4	186
5	187
6	191
7	192
8	198
9	198
10	200
11	202
Average	189.8

II. Six young were born on July 21 to a female which measured 843 mm. in total length.

No.	Total length
1	123
2	156
3	159
4	166
5	173
6	181
Average	159.6

Thamnophis sirtalis annectens Brown.

A female collected in Dallas County by Lawrence Curtis gave birth to 7 young on August 3, 1950. Two of these died and were discarded before measurements were taken.

No.	Total length	Tail length
1	208	57
2	212	52
3	218	51
4	219	51
5	228	61
Average	217.0	54.4

Hypsiglena ochrorhyncha texana Stejneger.

On March 10, 1950, a female which measured 488 mm. in total length and 63 mm. in tail length, was collected 19.3 miles north of San Ygnacio, Zapata County, Texas. She laid a clutch of 4 eggs, with smooth, non-granular shells, on April 25, 1950.

No.	Length	Width
1	27	11
2	29	9
3	29	10
4	32	10
Average	29.2	10.0

Two of these hatched on June 18.

No.	Total length	Tail length
1	146	23
2	153	22
Average	149.5	22.5

The young possess a ground color of light gray, which ends abruptly on the first and second scale rows. Primary dorsal body blotches, which number 47 in one specimen and 49 in the other, have an olive-brown color, and are from 2 to 4 scales long and from 3 to 6 scales wide. Spaces between blotches are 1 or 2 scales long. A series of smaller lateral blotches is located below, and alternates with the dorsal series. Below the lateral blotches is a third row of spots, occupying the second, third, and sometimes fourth row of scales.

Ventrum white and immaculate.

Top of head light gray with scattered spots of olive brown. A broad, brown postocular stripe extends backward from the eye, intercepting the four posterior upper labials, and widening at the neck to form the first nuchal blotch. Chin stippled with brown, most heavily pigmented on the mental, lower labials and chin shields.

Thirteen days after hatching, the young ate newly-hatched *Sceloporus olivaceus*, but refused to eat small *Anolis carolinensis* which were offered from time to time. Most of the day the snakes remained hidden beneath the sand in their cage, coming to the surface to prowl only after dark.

Trimorphodon biscutatus semirutus Smith.

There is no information in the literature concerning the eggs and young of this large Mexican opisthoglyph snake.

I. On November 2, 1948, a male, in an apparent attempt to mate with a much larger female cagemate, vigorously pursued her about the tree limbs in their cage. During this activity the male often interrupted his pursuit and, with neck raised at a slight angle, moved his head from side to side in a slow waving motion through a horizontal arc of nearly ninety degrees. This courting behavior continued for nearly three hours, but no coitus was observed.

At 5:01 p.m. on December 29, 1948, the female deposited the first of 20 eggs while loosely coiled in a tree limb more than 3 feet above the cage floor. During the following day and night, 18 additional eggs were laid, and on January 7 the last egg was deposited.

The eggs were of diverse shapes and sizes, non-granular and covered with an adhesive substance. Eggs which came in contact with one another after being placed in the incubation dish, readily adhered. On December 30, when 18 of the 20 eggs were laid, the shortest and longest time intervals between ovipositions were nine-and-a-half minutes, and one hour and twenty minutes, respectively. Each oviposition required from 14 to 48 seconds and averaged nearly 24 seconds.

From early morning until late in the afternoon on December 28, just prior to egg laying, the female was coiled in the cage pool. At no other time during her confinement was a predilection for water observed.

None of the eggs hatched. Dissection revealed their contents to be tough, spongy masses; doubtless a sign of infertility.

No.	*Length*	*Width*
1	30	19
2	31	19
3	31	19
4	31	20
5	32	19
6	33	18
7	34	21
8	35	19
9	35	23
10	36	23
11	37	24
12	38	23
13	40	25
14	41	17
15	43	22
16	43	23
17	43	24
18	43	24
19	43	24
20	45	24
	—	—
	Average 37.1	21.5

II. Twenty eggs were laid on March 3, 1949, by a female said to be from Colima, Mexico. Length of female, 1,793 mm.

No.	*Length*	*Width*
1	34	22
2	35	22
3	35	23
4	36	21
5	36	22
6	36	23
7	36	25
8	37	16
9	37	21
10	37	21
11	37	21
12	37	21
13	37	22
14	37	22
15	37	24
16	38	18
17	38	20
18	40	24
19	42	19
20	42	20
	—	—
	Average 37.2	21.3

Micrurus fulvius tenere Baird & Girard.

A large female was received May 15, 1950, from the Santa Rosa Hospital in San Antonio, Texas, after having bitten a man. After the accident, the victim brought the snake to the hospital for identification, not convinced that the bite was poisonous. At the Zoo the snake was placed in a cage with 3 other coral snakes. On May 16, and again on May 18, the smaller male in the cage mated with the new arrival. The latter died on June 3, 1950, presumably from the effects of an insecticide used to spray the moss in the cage. Dissection of the snake disclosed 9 eggs with thin, soft shells, not yet fully developed. Four of the eggs were accidently broken before they were measured. The remaining eggs measured:

No.	*Length*	*Width*
1	14	9
2	15	11
3	15	11
4	16	11
5	17	11
	—	—
	Average 15.4	10.6

Agkistrodon contortrix laticinctus Gloyd & Conant.

A female was collected by Jack Ried at Helotes, Texas, on August 14, 1950. On September 3 she passed 4 fully-developed, stillborn young.

No.	*Total length*	*Tail length*
1	225	38
2	226	38
3	228	36
4	230	37
	—	—
	Average 227.2	37.2

Crotalus atrox Baird & Girard.

A small female was collected during the night of July 14, 1949, several miles south of Nuevo Laredo, Tamaulipas, Mexico. The snake measured 887 mm. in total length. On August 20, between 3:21 p.m. and 5:36 p.m., she gave birth to 10 young.

No.	*Total length*[1]
1	214
2	282
3	291
4	291
5	291
6	293
7	295
8	296
9	301
10	316
Average	287.0

Crotalus lepidus lepidus Rafinesque.

A female of this subspecies from the Blackstone Ranch, 13 miles south of Sheffield, Terrell County, Texas, gave birth to 3 young on July 21, 1950. The mother measured 512 mm. in total length.

No.	*Total length*	*Tail length*
1	210	21
2	214	21
3	229	22
Average	217.6	21.3

The adult shows a departure from the normal coloration of this form in Texas, being exceptionally light with much-faded crossbands. The young, however, are more vividly colored, with dark gray (almost black) crossbands on a ground color of lighter gray.

Food items taken by the new-born snakes include young *Sceloporus olivaceus*, small *Anolis carolinensis*, and new-born mice.

Crotalus viridis viridis Rafinesque.

Two females, apparently gravid upon arrival at the San Antonio Zoo, were collected by Ted Klein at the Crow Ranch in Randall County, Texas.

I. The first of these, a female, 811 mm. long, was found dead in its cage on the morning of August 22, 1950. No reason for the death could be determined. Dissection of the snake revealed 12 well-developed embryos with considerable yolk still attached. The embryo males were easily recognizable, their penes being everted and very dark in color—an indication that parturition was still some time away.

No.	*Total length*	*Tail length*
1	193	11
2	195	14
3	200	12
4	204	12
5	204	15
6	206	11
7	208	13
8	209	16
9	210	14
10	211	13
11	212	17
12	214	17
Average	205.5	13.7

II. This female measured 850 mm. in total length. She died on August 27, 1950. A partially atrophied runt embryo was found tightly lodged in the uterus near the cloaca, and this was followed by 11 fully-developed, normal embryos, obviously ready to be born.

No.	*Total length*	*Tail length*
1	187	15
2	233	17
3	250	15
4	252	19
5	256	18
6	258	17
7	259	18
8	260	19
9	262	20
10	267	22
11	270	16
Average	250.3	17.8

Lepidochelys kempii (Garman).

Much of the following information was supplied by Mr. Jesse R. Laurence, of Corpus Christi, Texas, who donated to the Zoo the 4 hatchling turtles mentioned in the notes.

The mother, estimated to weigh about 125 pounds, was seen to crawl onto the beach at Padre Island, at a point about 45 miles southeast of Corpus Christi, Texas, March 23, 1950. The turtle laid approximately 100 eggs in a hole which she had dug in the beach, and later covered these with sand. The eggs were described as, "... about the size of ping pong balls, with firm but pliable shells." Eighteen of these were returned to the home of Mr. Laurence and placed in a bushel basket filled with sand. The eggs were 6 inches below the surface. The basket was kept outdoors where the sun could shine directly on it, and, occasionally, as the sand became dry, it was sprinkled with water. Sixty-two days after oviposition, on July 25, the eggs began to hatch, the young being about, ". . . the size of a silver dollar." At 120 days of age, 4 surviving young measured:

No.	*Carapace length*	*Carapace width*
1	105	91
2	117	93
3	119	94
4	121	95
Average	115.5	93.2

All possess 3 very pronounced longitudinal keels on the carapace, one along the vertebral row of shields and one on each row of costals. The median keel is much the highest.

[1] Measurements of these and the following rattlesnakes do not include the "button" or rattle.

The plastron has 4 longitudinal keels which are only about a third as high as those on the carapace.

The young turtles are uniformly black above, with narrow, white edging on all limbs and along the outer edge of the carapace. Beneath they are white with variable black markings.

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EXPLANATION OF THE PLATES.

All photos by Darling and Werler, San Antonio Zoological Society, unless otherwise credited.

Plate I.

Fig. 1. Female *Eumeces lynxe furcirostris* and young born to her on March 12, 1950. Total brood numbered five.

Fig. 2. Female *Eumeces brevilineatus* from near San Antonio, Texas, and clutch of 12 eggs laid May 18, 1949. The 3 buff-colored eggs, recognizable in the photo, desiccated soon after being laid. (Photo by MacAllister)

Plate II.

Fig. 3. Two *Eumeces brevilineatus* emerged from the eggs on June 13, twenty-six days after oviposition. The egg shells of the hatchlings are visible between the lizards. (Photo by MacAllister)

Fig. 4. Female *Abronia taeniata* from near Las Vigas, Veracruz, Mexico, and one of 4 young born to her on April 12, 1950.

Fig. 5. The young *Abronia taeniata* pictured here have crossbands which are shortened, and interrupted mid-dorsally, resulting in a pattern of small, paired spots. This probably is an atypical pattern. Two specimens of the same brood, not photographed, possess a pattern of transverse bands which extend uninterrupted across the dorsum.

Plate III.

Fig. 6. Female *Gerrhonotus liocephalus infernalis* and 3 young hatched from eggs which she laid on February 18, 1950.

Fig. 7. Newly hatched young and egg shell of *Gerrhonotus liocephalus infernalis*, April 2, 1950.

Plate IV.

Figs. 8, 9, 10. Stages in the egg laying of a *Masticophis mentovarius mentovarius*. The female is from near Alvarado, Veracruz, Mexico.

Plate V.

Fig. 11. Clutch of 17 eggs laid by *Masticophis mentovarius mentovarius* from Alvarado, March 23 to 25, 1950.

Fig. 12. New-born *Elaphe laeta laeta* hatched August 9, 1950.

Plate VI.

Fig. 13. Newly-hatched *Elaphe obsoleta confinis* from San Antonio, Texas. The larger dorsal blotches and shorter intervening spaces separating them readily distinguish these Texan hatchlings from a young Florida *confinis* collected near Wakulla Springs.

Fig. 14. Aberrant hatchling *Elaphe obsoleta confinis* from San Antonio, Texas.

Fig. 15. Female *Lampropeltis doliata annulata* from Christine, Texas, and clutch of 5 eggs laid on June 5, 1949. (Photo by MacAllister)

Plate VII.

Fig. 16. Eggs of *Hypsiglena ochrorhyncha texana* laid April 25, 1950.

Fig. 17. Female *Crotalus lepidus lepidus* from the Blackstone Ranch, Terrell County, Texas, and brood of newly-born young, July 21, 1950. Young snake at extreme left has not yet broken through the amniotic membrane which encloses it. The adult shows a departure from the normal coloration, being unusually light. The young are darker and more vividly marked.

FIG. 1.

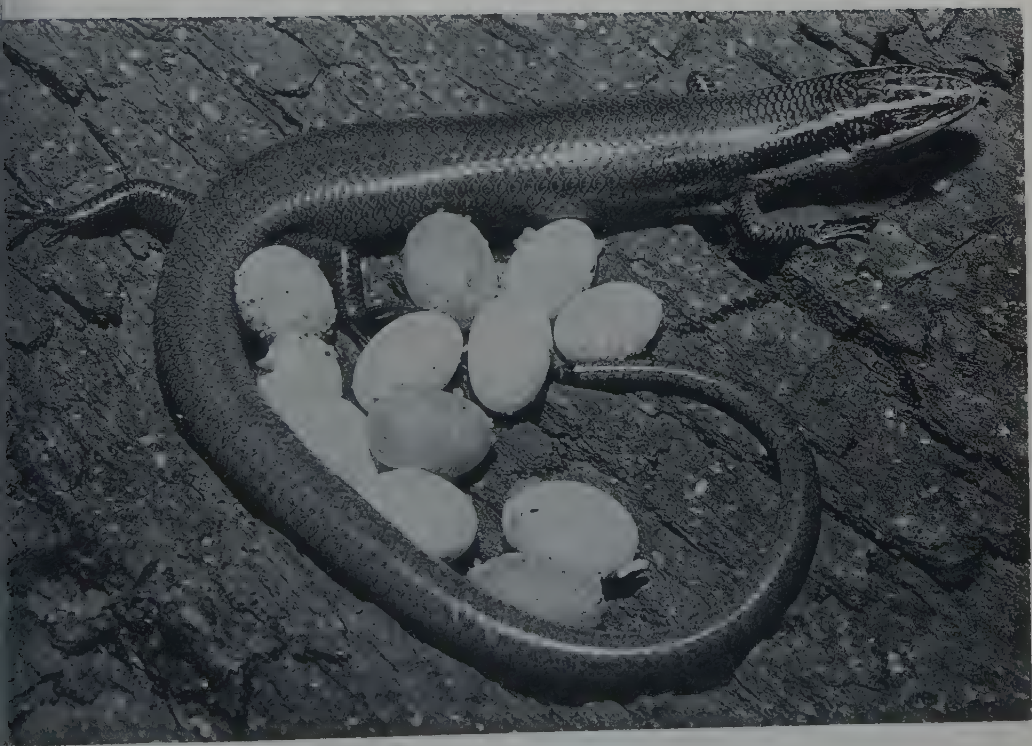

FIG. 2.

MISCELLANEOUS NOTES ON THE EGGS AND YOUNG OF TEXAN AND MEXICAN REPTILES.

FIG. 3.

FIG. 4.

FIG. 5.

MISCELLANEOUS NOTES ON THE EGGS AND YOUNG OF TEXAN AND MEXICAN REPTILES.

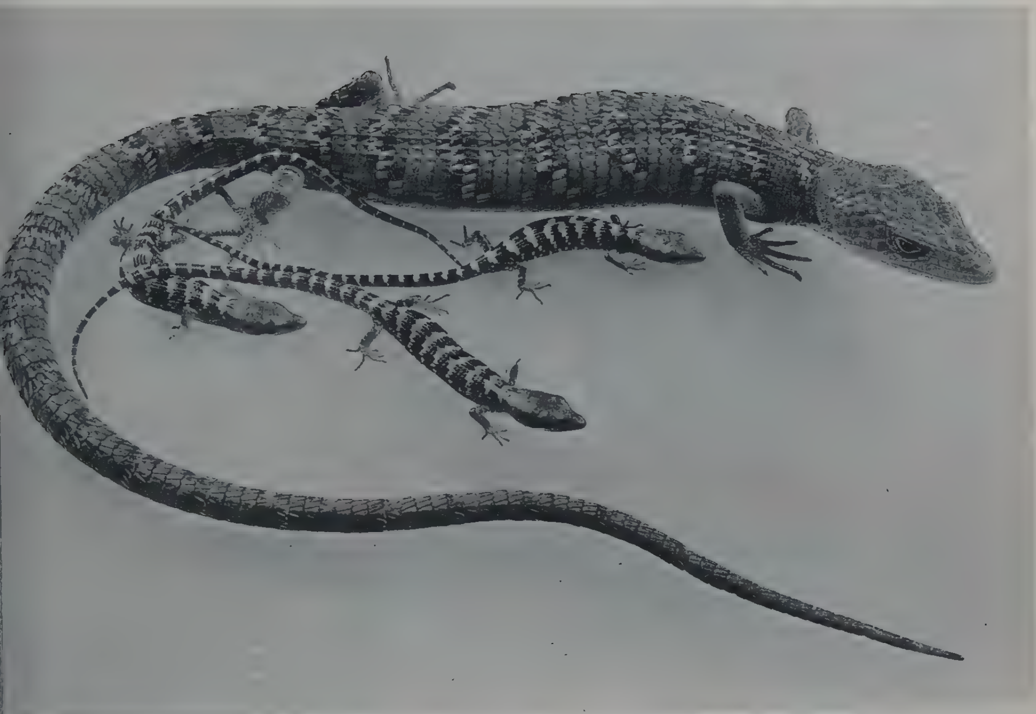

FIG. 6.

FIG. 7.

MISCELLANEOUS NOTES ON THE EGGS AND YOUNG OF TEXAN AND MEXICAN REPTILES.

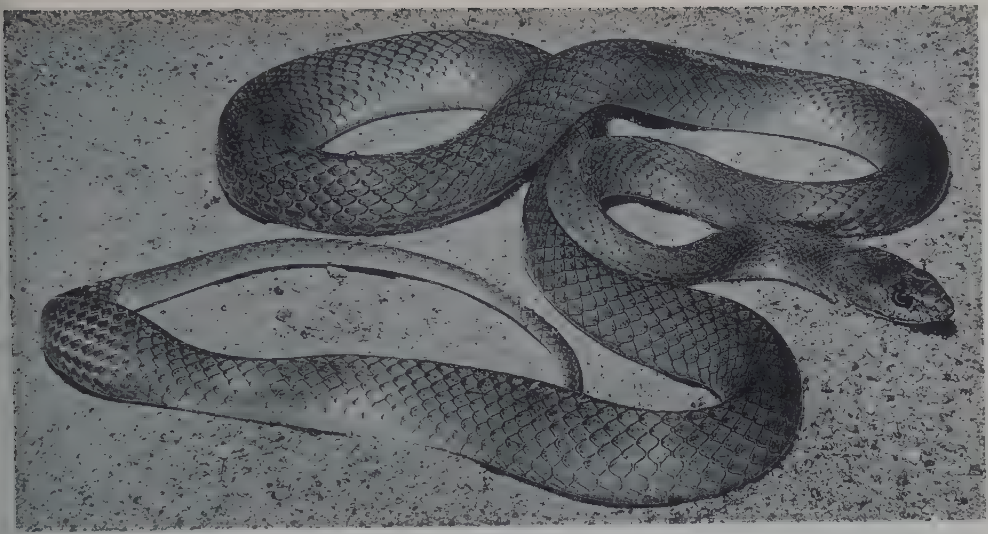

FIG. 8.

FIG. 9.

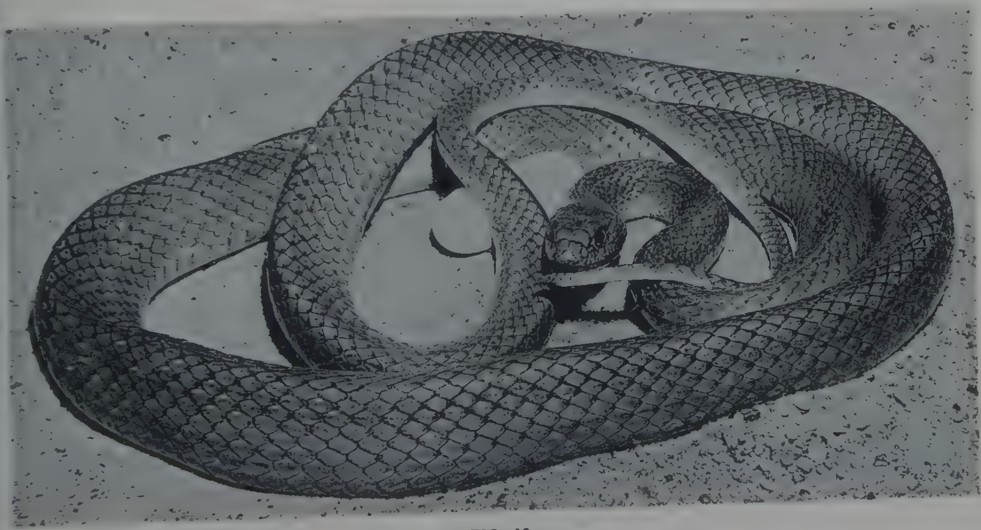

FIG. 10.

MISCELLANEOUS NOTES ON THE EGGS AND YOUNG OF TEXAN AND MEXICAN REPTILES.

FIG. 11.

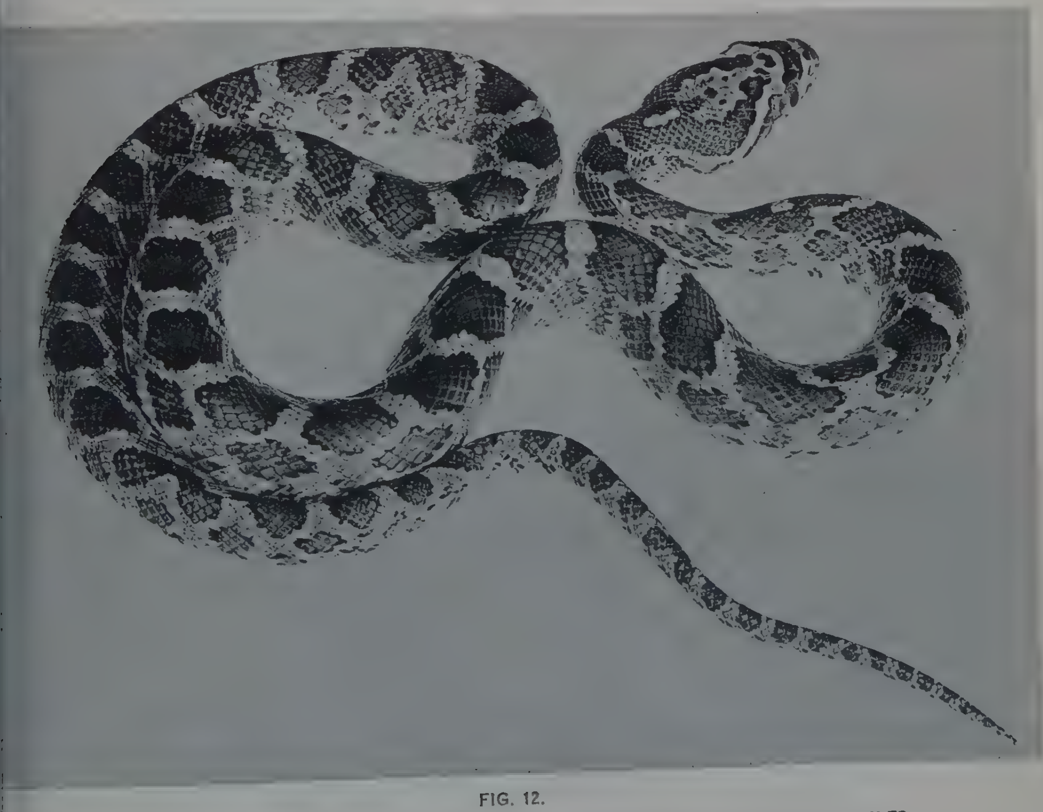

FIG. 12.

MISCELLANEOUS NOTES ON THE EGGS AND YOUNG OF TEXAN AND MEXICAN REPTILES.

FIG. 13.

FIG. 14.

FIG. 15.

MISCELLANEOUS NOTES ON THE EGGS AND YOUNG OF TEXAN AND MEXICAN REPTILES.

FIG. 16.

FIG. 17.

MISCELLANEOUS NOTES ON THE EGGS AND YOUNG OF TEXAN AND MEXICAN REPTILES.

4.

Sexual Behavior in the Guppy, *Lebistes reticulatus* (Peters).

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(Plates I-VII; Text-figures 1 & 2).

INTRODUCTION.

The guppy *Lebistes reticulatus* (Peters) is probably the best known of the poeciliid fishes. It is a viviparous fish, attractive, hardy and prolific and therefore popular with both aquarists and scientists. Recently several discussions on sexual behavior in the guppy have been included in papers primarily concerned with other aspects of behavior, morphology, physiology, genetics and taxonomy. In addition, numerous observations on this subject have appeared in the popular aquarium journals.

One of the most striking features of the sexual behavior in this species is the manner in which the males persistently pursue the females, and the great frequency with which the males jab at the genital region of the females with a momentary thrust of the highly modified anal fin or gonopodium. Although it is generally known that in most of these thrusts the gonopodial tip never quite reaches the female, in many of these reports the assumption is made, or implied, that these thrusts are true copulations and result in the transfer of sperm from male to female.

In a recent study on reproductive behavior in two closely related poeciliid fishes, *Platypoecilus maculatus* and *Xiphophorus hellerii* (Clark, Aronson & Gordon, 1948; in ms.), we found that this momentary thrust or jabbing response never resulted in insemination even when a definite contact of the gonopodium with the female's genital opening was attained. True copulation in *X. hellerii* and *P. maculatus* was determined to be a relatively prolonged act, lasting as much as 5.6 seconds, a period in which the male and female appear to be hooked together. Although these species have also been widely used in biological research for many years, these prolonged contacts had been reported briefly in only two previous studies. In view of this, we thought it possible that a prolonged type of contact in the guppy might have been overlooked, and that in this case also, the short but frequent thrusts, although part of the courtship pattern, were not involved in the actual insemination of the female.

In general there have been two views on the mechanism of copulation in the guppy. Several investigators assumed that the momentary thrusts were the behavioral acts which resulted in insemination of the female. At the same time they realized that the gonopodium often never quite reached the female. Hence they explained the copulatory act by postulating that the sperm (in the form of relatively large capsules or spermatophores) are shot at the female genital opening by the gonopodium. Other investigators considered definite contact between the tip of the gonopodium and the genital orifice of the female necessary for sperm transfer.

This present report presents experimental evidence on some phases of sexual behavior in the guppy, particularly on the act of insemination. This evidence will serve to correct some of the erroneous conjectures. By a combination of observational methods on mating behavior, by utilizing isolated females, and by using a smear technique for the detection of sperm in the female after insemination, we have been able to determine and define the act of sperm transfer. Supplementary studies are also presented which we hope will contribute to the general understanding of sexual behavior in this and related species.

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graphic equipment for taking action pictures of the guppy during courtship. The drawings of the gonopodia were made by Mr. Donn E. Rosen. Mrs. Marie Holz-Tucker and Miss Madeline Levy prepared the histological material and assisted in the interpretation of it.

Review of the Literature.

Three stimulating papers dealing with the problem of sexual selection in fishes have included descriptions and discussions of sexual behavior in *Lebistes* (Breder & Coates, 1935; Noble, 1938; and Haskins & Haskins, 1949). Less detailed discussions of sexual behavior in the guppy are presented in the genetic studies of Schmidt (1920) and Winge (1922), in a study of sexual dimorphism by Purser (1941), in two reports on gonad morphology (Stepanek, 1928, and Vaupel, 1929), and in an investigation of female receptivity by Jaski (1939). In the popular aquarium literature, numerous shorter articles on the guppy include discussions of sexual behavior (Brüning, 1918; Ritscher, 1927; Rummel, 1932; Zahl, 1933; Dempster, 1947; Gordon, 1948; Matsuyama, 1949; Latham, 1949; and many others). Of special note is the review article on the guppy by Fraser-Brunner (1947).

Act of Insemination.

Previous observers expressed a variety of ideas concerning the act of insemination. Some appear quite certain that they have witnessed it numerous times, while others claim it has rarely been seen (Stepanek, 1928) or never at all (Purser, 1941). Apparently, no observer has ever subjected his conclusions to an experimental test designed to show whether sperm transfer actually took place during the act he described. Many investigators, nevertheless, have presented some thought-provoking conjectures and it is a point of interest to review the various ideas concerning the copulatory act.

One of the earliest ideas on this subject was presented by Schmidt (1920) who suggested that an actual contact between the male and female is unnecessary. According to Schmidt, the male merely pursues the female, and when he approaches her he rotates his gonopodium so that the tip is close to her genital region. He then "actually discharges these balls [spermatophores] like shot, and, being glutinous, they easily attach themselves to the genital papilla of the female." Schmidt's hypothesis was accepted by Winge (1922), who in his extensive genetic investigations undoubtedly kept large breeding populations of guppies in his laboratory. It is easy to understand how this idea arose, since these non-contact thrusts of the gonopodium are the most frequently and easily seen of all the sexual behavior components. Indeed the authors of most of the reports in popular aquarium journals take it for granted that insemination is effected during this non-contact thrust. Recently Frazer-Brunner (1946) in his review article on the guppy stated: "Many people have watched Guppies in the hope of seeing the act of coitus, but have never been rewarded; nor will they be, for there is none—at least in the form they expect to see. . . . When the male has effected a strategic position with regard to the female, usually approaching from the rear, he porrects the gonopodium and 'dive-bombs' the female. The cannon-ball-like spermatophores . . . are fired machine-gun fashion at the genital opening of the female. The tip of the gonopodium being flexible but controlled, considerable accuracy is obtained. . . . The whole process is carried through in a flash, and is hardly possible to observe under ordinary conditions. It appears that the tip of the gonopodium is brought as near as possible to the female without being introduced."

However, Vaupel (1929) regarded the hypothesis of Schmidt and Winge as "clearly incorrect." "My own observations," he stated, "corroborated by those of several experienced aquarists, have assured me that the gonopod undoubtedly makes a contact with the genital opening of the female." Zahl (1933) reached a similar conclusion that insemination occurs when the male "makes a quick plunge forward and upward, and for an instant establishes contact between the tip of the gonopodium and the genital orifice of the female. . . . It all happens with such lightning speed, that if one isn't a careful observer, the act may escape his notice." Breder & Coates (1935) observed that during courtship a male shows an "energetic movement of the exceedingly mobile gonopodium to the side next to the female. . . . Normal, healthy males seem to be almost continually active in this regard, interrupting it only for feeding, but without considerable observation this is about all that can be usually noted in a small aquarium with few fish. Prolonged observation will reveal, however, that eventually the male gives up this procedure and directs a rather violent thrust of the gonopodium toward the genital pore of the female. A momentary contact effects the transfer of the encapsuled spermatozoa." A similar view is shared by Haskins & Haskins (1949), who suggest that the "spermatophores are probably transferred along the male gonopodium to the genital pore of the female in one or more contacts . . . swift and of momentary duration." It is interesting to note that in the last mentioned article the authors report that prolonged contacts are the typical means of insemination in two closely related species, *Micropoecilia parae* and *Poecilia vivipara*.

Purser (1941) observed in detail the forward movements of the gonopodium during what we will refer to in this paper as the *swinging* and *thrusting* behaviors. However, he did not believe these to be acts of insemination but assumed that during coitus the gonopodium maintains the same position.

After the present study had been completed, the important paper by Stepanek

(1928), published in an obscure Czechoslovakian journal, was called to our attention. Here we found the only record in the literature of a prolonged gonopodial contact in the guppy.

Stepanek reports that after four years of observations on *Lebistes* he is convinced that spermatophores are ejaculated only during a prolonged contact of several seconds duration, during which period the gonopodium is inserted into the female. He witnessed this rare behavior only twice. He suggests that the terminal hook on the third ray of the gonopodium functions as a holdfast organ, and that when the tip of the gonopodium is inserted, the female cooperates by "closing over [presumably the sphincter of the genital aperture] and holding on." In this connection, however, the necessity of a terminal hook for insemination has been ruled out by recent amputation experiments of Sengün (1949). Stepanek's observations, however, are particularly significant because he is the only one to describe a long copulation and to suggest some degree of cooperation by the female. He appears to be the only author who has recognized the actual nature of insemination, as we believe we have validated it, in this fish.

Behavior of the Female.

Aside from Stepanek's conclusions, and a questionable report by Jaski (1939), others agree on one point, namely, that there is a complete lack of cooperation on the part of the female guppy during the act of insemination (Breder & Coates, 1935; Fraser-Brunner 1947; Gordon, 1948; Haskins & Haskins, 1949; and most aquarists). Thus according to Breder & Coates (1935), "This actual transfer of material seems to occur only after the male has slipped up to the seemingly unsuspecting female. Not infrequently a male may be seen to court one fish and as she flees succeed in fertilizing another. . . . No females at any time have been observed to show other than escape reactions to the male attentions." Fraser-Brunner (1947) states, "All the sexuality seems to be on the part of the male. The female never appears to display the slightest interest, but generally tries to evade the attentions of her mate, or even drive him away." He goes on to say that the males put on a courtship display. "The female, however, seems never to be attracted by this, and when eventually the male makes his quick dart, it is to take her unawares." Similarly Haskins & Haskins (1949) report that the "female remains throughout an apparently entirely passive agent in the whole act of fertilization. There is normally no marked halting in swimming, and no evidence of cooperation in any active way, except possibly in the case of females which have been reared in isolation in the laboratory." The aquarists likewise say that the female constantly flees from the male during courtship.

On the other hand, Stepanek's suggestion that the female responds by closing over the male gonopodium when it is inserted in her oviduct indicates a complementary reaction of the female during the act of insemination. Jaski (1939) proposed a rather unique theory concerning female receptivity. Based on extensive studies, Jaski claimed to have discovered a definite estrous cycle of about 4 to 6 days (in females kept at temperatures over 22° C.) which is dependent on ovarian secretions and which can be influenced by a hormone, copulin, secreted into the water by the male. According to him, the ovarian secretions influence the angle at which the female swims. As receptivity increases, he says, the female assumes an oblique position in relation to the surface of the water and her head is tilted upward. Receptivity is indicated by a change in angle of about 20°. This angle of the female's body, he suggests, may facilitate the copulatory act. Jaski's studies, although frequently referred to in recent aquarium literature, have never been confirmed and much of it is opposed by our findings.

Resume of the Mating Pattern.

Before a detailed analysis of our observations on the mating behavior of the guppy is attempted, it is desirable to present a general description of the mating activity and to define the terms adopted for the various behavioral patterns. The names given to many of these acts are taken from recent studies by Clark, Aronson & Gordon (1948; in ms.) and Schlosberg, Duncan & Daitch (1949) on the related poeciliid fishes *Platypoecilus maculatus*, the platyfish, and *Xiphophorus hellerii*, the swordtail.

When a pair of guppies is placed in an observation aquarium, the male may ignore the female for some time but more often he will persistently pursue the female and jab at or near her genital aperture with the tip of his extended gonopodium. During this period of pursuit the following types of behavior are observed:

1. *Gonopodial Swinging*. This term refers to the movement of the modified male anal fin or gonopodium which is coordinated with the forward motion of one of the pelvic fins. During "swinging," the gonopodium is swung laterally and forward. It continues to rotate until the tip points anteriorly and the edge of the gonopodium, which in the resting position is dorsal, now faces ventrally. Meanwhile the pelvic fin on the same side of the body is also brought forward and the gonopodium appears to be braced against the pelvic fin for a fraction of a second. The gonopodium and pelvic fin then return to their normal positions (Plates I and II). The whole "swing" is accomplished in much less than a second. Successive swings usually are made to alernate sides. The dorsal fin, unless already erect, is erected simultaneously with the forward swing of the gonopodium. The completion of several swings within one minute evidently indicates a sexually active

male. In some pairings, however, when the female is easily approached by the first advances of the male, copulations with sperm transfer may occur almost as soon as the male (or female) is introduced into the tank with the other fish and before there has been any swinging of the gonopodium. This indicates that swinging as such in the presence of the female is not necessary for insemination. Occasionally swinging is observed in isolated males, and hence it is possible that the highly active males mentioned above may have been swinging before their introduction into the mating tank.

2. *Body Curving*. The body of the male becomes strongly curved either in the form of a simple arc or "S"-like with the tail bent sharply to one side. This position may be held as long as three seconds during which time the male appears tense, and its body quivers. Body curving often starts while the male is up to six inches from the female and therefore, she is still within his field of vision. While this behavior is in progress the male generally moves toward the side of the female. A "thrust" often follows, and this in turn occasionally is followed by a short or long copulation (see below).

When a male first encounters a female, body curving is usually accompanied by a fully expanded caudal fin (a spectacular sight in highly colored and longtailed varieties). However, as the courtship progresses, the caudal fin is generally folded when the male approaches the female.

3. *Thrusting*.[1] In this behavior, the male swims alongside the female (either directly or following body curving), brings his gonopodium forward and to the side facing the female and thrusts at the genital area of the female in a quick jabbing movement (Plate III). At the same time the pelvic fin is brought forward as in the swinging behavior, suggesting that among other functions it serves as a buttress or prop for the gonopodium. The male usually thrusts at the female from a position slightly below her so that the thrust is actually an upward as well as a lateral or sidewise movement (Plates IV, V and VI).

Two types of "thrusting" are recognized and termed the non-contact thrust and the contact thrust. In the non-contact thrust, the male jabs his gonopodium close to the female genital region but does not touch her body. This is the most common type of thrusting observed. During contact thrusts the gonopodium of the male touches the female's body lightly for a momentary contact at her genital region.

4. *Short Copulations*. These are similar to contact thrusts except that (1) their duration of contact is slightly longer, at least 0.8 seconds, and (2) the act is associated with a stationary position of the female. The short copulation is not easily distinguished from the contact thrust except after considerable experience in observation. It is usually preceded by body curving. Males may transfer hundreds of spermatophores to the female during a single copulation of this type.

5. *Long Copulations*. These resemble short copulations but last for a longer period of time. They average 1.3 to 2.4 seconds, but may be much longer. During a long copulation the male may circle under the body of the female while holding the tip of the gonopodium close to the genital aperture of the female, completing two entire circles before the fish swim apart. Long copulations are always preceded by body curving. Insemination frequently but not invariably takes place at this time.

Receptivity of the Female.

During most of the courtship, the female swims away when the male approaches her. In many cases she swims rapidly and excitedly, fluttering up and down the side of the aquarium with her mouth rubbing the glass. A female often slaps her tail at the male that is sidling or thrusting at her. This "tail-slapping" behavior in fishes has been described for cichlids (Noble & Curtis, 1939; Aronson, 1949), monacanthids (Clark, 1950) and xiphophorins (Clark, Aronson & Gordon, in ms.). Sometimes a female will rest close to the bottom of the aquarium and although the male may persistently swim around her, he does not succeed in thrusting at her.

On some occasions when a male approaches in a "body curve," the female may suddenly become quiescent and come to an almost stationary position at a point away from the substratum. Short or long copulations generally follow. In a few instances, a female that was constantly fleeing the courting male gradually assumed the stationary receptive position. This change occurred after the male remained "face to face" with the female for a long period while blocking her forward movements by constantly maintaining this position in front of her. In each case a copulation followed. It thus appears that this stationary position assumed by the female is a sign of receptivity.

Observations on Mating Behavior.

Material and Methods.

In all, 37 females were tested with 28 males in 56 observation periods which varied from one-half minute to three hours and 58 minutes in length. Observations were made on mature pairs of fish in two-gallon aquaria (25.0 cm. long × 16.5 cm. wide × 18.0 cm. high). All fish were kept in a greenhouse where the temperature varied between 25° and 28° C. Except for group I (see below), the incidence and duration of the various items of behavior observed were recorded on an electrically operated polygraph recording apparatus (see Clark, Aronson &

[1] In earlier studies on the platyfish and swordtail (Clark, Aronson & Gordon, 1948; 1949) we refer to this behavior as "jabbing" but have since adopted the use of the term "thrusting" from Schlosberg, Duncan & Daitch (1949).

Gordon, in ms.). All fish used were kept isolated for at least one day before their first pairing, and were immediately separated at the end of the test.

After all observations in which the male approached the female with a porrected gonopodium, the female was tested for the presence of sperm. The method used was developed by Clark, Aronson & Gordon (1948 and in ms.) in *Platypoecilus maculatus* and *Xiphophorus hellerii* and was found by numerous experimental tests to be highly reliable. In the test, a fine pipette containing a drop of 0.8% saline solution is inserted well into the female gonaduct. By means of a rubber tube held in the experimenter's mouth at one end and ending in a pipette at the other, the drop is gently expelled into the genital duct and then the fluid sucked back into the pipette. The redrawn drop is then examined under the microscope. Negative sperm smears are rechecked at least one additional time. That the technique is adequate to test for sperm transfer in *Lebistes* is indicated by the records kept on 21 virgin females that were paired with males, smeared, then set aside and later checked for embryos or young. Of these, 17 gave negative sperm smears and in these negative cases no embryos or young were recovered. Of the four females with positive smears after mating observations, two produced young and two did not.

In all our observations we used either virgin females or females (taken from stock tanks) which were isolated until sperm could no longer be recovered from them by the smear technique. This usually took about one week.

Three sets of observations were made. In group I (Table 1), we used four special strains of fish, the females of which were virgins. The fish marked A were a golden variety; B were albinos; C were of a cream strain; and D were wild type.[2] Group II (Table 2) were all of the wild type. All the females and males 1, 2, 5 and 6 were virgin fish reared in our laboratory from two broods born on March 31, 1949. In these broods the males were segregated from the females at the first signs of sexual dimorphism. Males 12 through 15 were taken from a stock of the Haskins' strain of wild type guppies. They had been raised with females and thus had opportunity for sexual experience prior to their use in our experiments. Group III (Table 3) consisted of mature guppies of unknown pedigrees taken from a large community tank. The males and females in this group probably all were sexually experienced. The females, although not used in observations until they gave negative sperm smears, probably had stored sperm and several dropped broods during the days they were used for observations.

In groups I and II, the female was introduced into the male's tank at the beginning of the observation. This technique of bringing the female to the male's quarters has been used by animal breeders (Winge, 1927; Beach, 1947) and was found to be very effective in our earlier experiments on xiphophorin fishes. In group III, the male was introduced into the female's tank. This method proved to be equally efficacious in the guppy.

Results.

The results of the three sets of observations are given in Tables 1, 2 and 3 and are summarized in Table 4.

Short and Long Copulations. During twelve of the 56 observation periods, the female was inseminated. In each of these cases at

[2] Dr. Caryl P. Haskins kindly supplied us with these strains.

TABLE 1.

Observational Results on Group I (Virgin Females)[1].

Female	Male	Length of Observation (in min.)	No. of Thrusts		No. of Copulations[2]		Smear	Embryos[3]
			Non-contact	Contact	Short	Long		
A-1	A-1	5	0	0	0	8	negative	absent
A-2	A-2	10	0	0	0	0		
A-2	A-3	2.5	2	0	0	1	positive	absent
B-1	B-1	15	7	3	0	0	negative	absent
C-1	C-1	6	0	0	0	0		
C-1	C-3	20	0	0	0	0		
C-2	C-2	20	0	0	0	1	negative	absent
D-1	D-1	18	0	0	0	5	negative	absent
D-2	D-2	20	5	1	0	0	negative	
D-3	D-3	16	3	1	0	3	positive	present
D-3	D-5 and 6	16	0[4]	0[4]	0	0		
D-4	D-4	16	0	0	0	0		
D-4	D-7 and 8	12	7[4]	0[4]	0	1	negative	absent
Total	9 / 15	176.5	24	5	0	19		
Mean		13.6	1.8	0.4	0	1.5		

[1] All observations were made on 12/7/48.

[2] All these females remained stationary when males approached and thrust. The resulting copulations were all of the long circling type.

[3] Females dissected and ova examined on 12/27/48 (20 days later).

[4] Male thrusts at each other not recorded.

TABLE 2.

Observational Results on Group II (Virgin Females).

Female	Male	Observation Date	Observation Length (in min.)	No. of Thrusts Non-contact	No. of Thrusts Contact	No. of Copulations Short	No. of Copulations Long	Duration of Long Copulation (in sec.)	Smear	Embryos[1]	No. of Swings	No. of S-curves	No. of Swings per min.	No. of S-curves per min.	No. of Thrusts per min.
1	1[2]	1/4/50	20	0	0	0	0				26		1.3		
1	2[2]	1/4/50	14	0	0	0	0								
1	5[2]	1/4/50	12	0	0	0	0								
1	6[2]	1/4/50	12	0	0	0	0								
1	13	1/5/50	12		21	0	0		negative		22	3	1.9	0.3	1.8
1	12	1/6/50	13		19	0	0		negative	absent	13		1.0		1.5
2	12	1/5/50	12		11	0	0		negative		7		0.6		0.9
2	13	1/6/50	12		3	0	0		negative		23	4	1.9	0.3	0.3
2	15	1/9/50	22		3	0	0		negative	absent	17	6	0.8	0.3	0.1
3	14	1/5/50	14		6	0	0		negative		34	15	2.4	1.1	0.4
3	14	1/6/50	12		8	0	0		negative		11	2	0.9	0.2	0.7
3	12	1/9/50	16		38	0	0		negative	absent	13		0.8		2.4
4	15	1/5/50	14		2	0	0		negative		14	2	1.0	0.1	0.1
4	15	1/6/50	12		0	0	0		negative		8	1	0.7	0.1	0.0
4	13	1/9/50	22		4	0	0		negative		18	1	0.7	0.05	0.2
4	12	1/15/50	14	1	0	1	0		negative	absent	30	6	2.1	0.4	0.1
5	14	1/9/50	22	12	4	0	0		negative		19	6	1.2	0.8	0.7
5	14	1/15/50	15	10	2	0	0		negative	absent	31	18	2.1	1.2	0.8
6	13	1/15/50	30	11	2	0	0		negative	absent	41	42	1.4	1.4	0.4
7	15	1/15/50	23	5	1	0	0		negative	absent	19	5	0.8	0.2	0.3
8	13	1/15/50	90	131	12	0	0		negative	absent					1.6
9	12	2/8/50	20	2	0	0	0		negative						0.1
9	13	3/7/50	36	95	3	0	1	2.0	positive	absent	95	7	2.6	0.2	2.7
10	13	2/20/50	238	105	7	1	0		negative	absent	220	211	0.9	0.9	0.5
11	13	2/24/50	176	212	22	5	0		negative	absent	191	96	1.1	0.5	1.3
12	15	2/27/50	80	31	5	4	0		negative		225	23	2.8	0.3	0.5
12	13	3/14/50	84	70	5	1	0		positive	present		121		1.5	0.9
13	13	3/2/50	80	57	5	2	0		positive	? (♀ died)	141	113	1.8	1.4	0.8
14	13	3/8/50	22	8	5	0	1	2.0	negative	absent	97	21	4.4	1.0	0.6
15	13	3/10/50	60	22	12	1	0		positive	? (♀ died)	138	40	2.3	0.7	0.6
16	13	3/13/50	60	26	8	0	0		negative	absent		67		1.1	0.6
Total 16	8	31[3]	1269.0	789[4]	93[4]	15	2				1453[5]	810[5]			
Mean			40.9	49.9[4]	5.8[4]	0.5	0.1				60.5[5]	36.8[5]	1.6	0.6	0.7

[1] Females dissected 17-20 days after last observation.
[2] Virgin male.
[3] Total number of observations.
[4] Sum of last 16 observations only.
[5] Total and mean only for observations where figures are listed.

Observational Results on Group III (Non-virgin Females).

Female	Male	Observation Date	Observation Length (in min.)	No. of Thrusts Non-contact	No. of Thrusts Contact	No. of Copulations Short	No. of Copulations Long	Duration of Long Copulation (in sec.)	Smear	No. of Swings	No. of S-curves	No. of Swings per min.	No. of S-curves per min.	No. of Thrusts per min.
21	21	4/3/50	2	0	0	0	1		positive	0	2	0.0	1.0	0.0
22	22	4/3/50	10	0	0	1	0		positive	19	5	1.9	0.5	0.0
23	22	4/4/50	5	2	0	0	1	2.4	positive	17	4	3.5	0.8	0.4
24	21	4/4/50	3	0	0	0	1	1.5	positive	4	2	1.3	0.7	0.0
25	23	4/4/50	16	0	0	0	1	1.3	negative	24	7	1.5	0.4	0.0
26	24	4/4/50	5	4	0	0	1	2.0	negative	12	9	2.4	1.8	0.8
27	22	4/11/50	9	4	1	0	1	1.7	positive	24	14	2.7	1.5	0.6
28	21	4/11/50	26	3	3	0	0		negative	54	49	2.1	1.9	0.2
29	25	4/11/50	7	0	0	0	1	1.7	negative	0	1	0.0	0.1	0.0
30	24	4/11/50	1	0	0	1	0		positive	0	1	0.0	1.0	0.0
31	24	4/11/50	0.5	0	0	1	0		negative	0	1	0.0	2.0	0.0
32	24	4/11/50	30	5	4	0	0		negative	53	67	1.8	3.2	0.3
Total 12	5	12[1]	114	18	8	3	7			207	162	17.2	14.9	2.3
Mean			9.5	1.5	0.7	0.3	0.6			17.3	13.5	1.4	1.2	0.2

[1] Total number of observations.

least one short or one long copulation was found to have taken place. The positive sperm smears contained thousands of sperm. In many cases, a slight pressure on the abdomen of the female released a small amount of milky white fluid from the genital aperture which could be sucked into a dry micropipette. This fluid, when examined under the microscope, was found to be teeming with highly motile spermatozoa. In four cases these heavy sperm smears were recovered after a single short copulation (Table 3, females 22 and 30) or after long copulations in which no thrusting, either contact or non-contact, had taken place (Table 3, females 21 and 24). Our data indicate that a short copulation is as effective as a long copulation for the transfer of sperm. Some individual males (Table 2, male 13; Table 3, male 22) inseminated females with both types of copulations during different observations, but no males engaged in both a short copulation and a long copulation in a single observation.

Even when experienced males were used (see females 4, 10, 11, 12 and 14 in Table 2, and females 25, 26, 29 and 31 in Table 3), short and long copulations sometimes did not effect sperm transfer. In two cases, as many as 5 and 8 long copulations did not result in insemination of the females (see Table 1). The eight virgins (Tables 1 and 2) that had negative smears after copulation were sacrificed 17 to 20 days later and none contained embryos.

Non-contact and Contact Thrusts. During 22 observation periods, the females received from 2 to 234 non-contact or contact thrusts without any short or long copulations taking place. None of these females was inseminated. Nine of these (Tables 1 and 2) were sacrificed 17 to 20 days later and none contained embryos.

Non-contact and contact thrusts were far more numerous than copulations. A total of 1,061 thrusts were recorded for the 56 observation periods, and most of these (about 88%) were of the non-contact type. Short copulations and long copulations occurred much less frequently—a total of only 14 of the former and 28 of the latter being recorded.

Swinging behavior, S-curving and thrusting were recorded in most of the observations for groups II and III. Since the observation periods were of unequal length, comparisons were made of the frequency per minute of these acts in observations where copulations did and did not take place. These comparisons (Table 5) show no significant differences, except in the case of the swinging behavior, which appeared to be significantly higher in observations where copulations occurred.

Experiments on Partial Amputations of Gonopodial Elements.

The highly specialized parts of the gonopodium of poeciliid fishes have stimulated

TABLE 4.

Summary of 56 Mating Observations.

Type of Thrust or Copulation	*Number of Observations*	*Number of Observations Resulting in Insemination of the Female*	*Per cent. of Observations Resulting in Insemination of the Female*
None	10	—	—
Non-contact and contact thrusts only	22	0	0
Short copulations[1]	9	5	55.6
Long copulations[1]	15	7	46.6

[1] Non-contact and contact thrusts also occurred in many of these observations.

considerable speculation as to their function, and numerous discussions on this topic have appeared in the literature. Brief reports by Langer (1913), Klemm (1924) and Stepanek (1928) indicate that sperm transfer does not occur when the gonopodium is first amputated. However, it has been established that *Lebistes* males may regenerate gonopodia which are structurally normal (Hopper, 1949) and are functional (Sengün, 1949). In an earlier study on the platyfish, *Platypoecilus maculatus*, (Clark, Aronson & Gordon, 1949), it was found that after amputation of the minute tip of the gonopodium no regeneration took place, and males which previously were capable of inseminating females were no longer able either to copulate or to inseminate females. For that fish, it was concluded that this small complex tip was essentially a holdfast mechanism that operates during the copulatory act at which time the male appears to have a definite grip on the female. However, our observations on the act of insemination in the guppy show that this act is not always as definite as in the platyfish. Although copulation in the guppy may last as long as in the platyfish, the male and female do not appear "hooked" together. In view of these differences we decided to investigate the effect of the removal of various parts of the gonopodium on the inseminating ability of the male guppy. The following amputations were performed:

Group A—The major portion of the gonopodial hood[3] was removed from each of five males (Text-fig. 2A).

Group B—The distal quarter of rays 3, 4 and 5 was removed from each of five males (Text-fig. 2B).

Group C—The tip of rays 3, 4 and 5 which includes the hooks terminating ray 5 was removed from each of ten males (Text-fig. 2C).

Following the operation each male was paired with a female in a two-gallon aquarium. The females were checked for presence of sperm after two and six days.

The females used in these studies were not virgins. They were removed from a stock tank two to three weeks prior to the experiment and isolated in individual two-gallon aquaria. In every case a negative sperm smear was obtained just prior to the test with an operated male.

The results of these three types of gonopodial amputations on the ability of males to inseminate females are presented in Table 6. They indicate that the gonopodial hood is not necessary for insemination, but that amputation of the distal portion of rays 3, 4, 5 and even the small distal tip prevents insemination from taking place for at least six days after the amputation. During this period little regeneration occurs. After one month the males of group C showed no significant regeneration of rays 3, 4 and 5.

Histology of the Gonopodial Hood.

Because of the unusual appearance of the gonopodial hood, a brief histological study of this structure was undertaken with the hope of gaining some understanding of its physiology in relation to copulation. The hood is shaped like an elongated trough, in which the concavity faces dorsally when the gonopodium is in the resting position (Pl. VII, Fig. 15, *c.*). Towards the distal end the concavity becomes rather narrow, and finally terminates as a short blind canal or caecum near the tip of the hood (Pl. VII, Figs. 16 and 17, *ca.*).

The outer or ventral surface of the hood, as well as the concavity or dorsal surface, is formed by a stratified epithelium two to four cells in thickness (Pl. VII, Figs. 15, 16 and 17, *ep.*). Occasional goblet cells are found in this epithelium, particularly towards the distal end. At the tip of the hood the epithelial layer becomes considerably thicker (Pl. VII, Fig. 17) and the deeper lying cells on the dorsal surface are long and spindle-shaped. The cytoplasm of some of the epithelial cells contains fine, weakly staining granules. These may be the oxyphilic granules described by Purser (1941).

Beneath the epithelial layer on the ventral side there is a thick, hyaline structure which stains a deep pink with haematoxylin and eosin (Pl. VII, Figs. 15, 16 and 17, *co.*). Purser (1941) has termed this the core. This layer is covered on both sides by thin core membranes (*c.m.*) which stain a deep purple in contrast to the pink of the compact

[3] The term "prepuce hood" is commonly used in the literature but we prefer to omit the word "prepuce" as it is redundant and may incorrectly imply an homology or relationship with the foreskin of the penis.

TABLE 5.

A Comparison of Male Behavior in Observations in Which Copulations Did and Did Not Take Place.

	Observations With Copulations			*Observations Without Copulations*				
Behavior	*Number of Observations*	*Mean Frequency of Behavior Per Minute* $\pm \sigma_M$	σ	*Number of Observations*	*Mean Frequency of Behavior Per Minute* $\pm \sigma_M$	σ	*Mean Difference Per Minute*	*"P Value"*
Swinging	6	2.3 ± .39	1.09	16	1.2 ± 14	.55	**1.04**	<0.01
S-curving	9	0.8 ± .17	0.50	13	0.6 ± .13	.49	.22	0.3
Thrusting	9	0.9 ± .23	0.70	18	0.7 ± .16	.69	.17	0.5

core. The latter curves inwardly around the edges of the trough. At this point the two core membranes fuse and extend from side to side just beneath the epithelium lining the trough. Under high magnification (950×), fine irregular lines can be seen in the compact layer, suggesting a fibrous composition. Cross sections of the core stained with eosin suggested a superficial resemblance to teleost scale. Moreover, when the epithelium and connective tissue of a fresh preparation were removed by immersion of the hood in a 1% solution of KOH, the core remained as a tough, transparent, curved sheet about the size of an average guppy scale. However, specific tests for calcium (Langeron's alizarin red S and von Kóssa's silver nitrate, Lillie, 1948) were negative. The Taenzer-Unna acid orcein test for the presence of compact elastic fibers (Lillie, 1948) also was negative. The core stained readily with methylene blue and took up the green (acid stain) of Masson's trichrome technique. The supposition is that we are dealing with a special type of dense, resilient, connective tissue in which all of the cellular elements are located at the periphery in the thin core membrane.

Between the core and the fused core membranes lining the concavity, there is a broad layer of loose connective tissue (Pl. VII, Figs. 15 and 16, *c.t.*) which is highly vascular and also contains bundles of longitudinally-running nerve fibers. Melanophores, when present, are found in this layer. Two large sinusoidal blood vessels run through the connective tissue layer, one on each side of the trough. Study of the living material reveals that the main right vessel (*r.b.v.*) carries the blood distally, while the main left vessel (*l.b.v.*) carries the blood in a proximal direction. Two major anastomoses occur between these vessels, one near the tip and the other near the middle of the hood.

Whole mounts of the hood stained with methylene blue (Pl. VII, Fig. 18) reveal several compact bundles of longitudinally-running nerve fibers, and at the tip a rather extensive plexus of fine nerve fibers. In cross sections stained with methylene blue, some of these fine fibers could be seen terminating in small bulbs suggestive of nerve endings. A whole mount stained with the gold chloride method of Ranvier (McClung, 1929) verified the extensive innervation of the gonopodial hood.

Mating Activity Among Guppies in Commuity Tanks.

In several previous studies on *Lebistes*, Breder & Coates (1935), Fraser-Brunner (1947), and Haskins & Haskins (1949) implied that male guppies copulate with and inseminate females at a very high frequency, perhaps hundreds of times daily. In view of our finding that copulation actually is a rather infrequent event in test pairings, we set out to determine the frequency of such behavior among fish in community tanks.

TABLE 6.

The Effects of Partial Amputations of the Gonopodia on the Inseminating Ability of Male Guppies.

Group	*Male*	*Part of Gonopodium Removed*	*Sperm Smears on Female*	
			After 2 Days	*After 6 Days*
A	1	hood	positive	—
	2		negative	negative
	3		positive	—
	4		negative	positive
	5[1]		positive	—
B	6 through 10	distal quarter of gonopodium	all negative	all negative
C	11 through 20	distal tip of gonopodium including hook on ray 5	all negative	all negative

[1] This male had a long copulation with the female about 10 minutes after pairing. The female was smeared a few minutes later and found to be heavily inseminated.

This could only be estimated by indirect methods.

First, it was necessary to find how many days following an insemination a positive smear could be obtained. A single effective copulation results in the transfer of hundreds of spermatophores. When a sperm smear is taken within a few hours after an effective insemination, the fluid in the female oviduct is macroscopically "milky" in appearance. This milky fluid can no longer be recovered from females two days after copulation. At this time the sperm smear appears clear although many hundreds of spermatozoa are still seen upon microscopic examination, although they are not nearly as dense as in a "milky smear." After seven days, the number of sperm in the smear is considerably less in most cases, and occasionally the smear is entirely devoid of sperm. By the eleventh and fourteenth day, few, if any, sperm are recovered.[4] Our data are summarized in Table 7.

In the light of this schedule of smear changes on successive days after insemination, random samples of females were now taken from stock tanks for examination. Each tank contained many males. Smears were made in all cases shortly after females were removed from the tanks. The results of this examination are summarized in Table 8. Only 26 females (out of 54) contained sufficient sperms to indicate a recent insemination, and only six of these appeared to have been inseminated within the preceding day. More than half of the females tested (28) appeared not to have been inseminated for more than a week.

Modification of the Smear Technique for the Detection of Sperm.

As indicated above, it is difficult to recover sperm two weeks after insemination by the ordinary smear technique. A more radical method was required. Ten females tested on April 28, 1950, (Table 8) with positive sperm smears were retested by the smear technique on May 11, 1950, after 13 days of isolation and all gave negative smears (two smears were taken from each female). These same females were then smeared a third time on the same day but this time the drop of fluid was blown into the genital tract, and the tip of the micropipette was rubbed against the folds of the oviduct a few times before the drop was sucked back into the micropipette. The smears obtained in this manner gave positive signs of sperm in six of the ten females, less than ten sperm in four cases, about 50 in one, and about 150 in another.

[4] The reduction in the amount of sperm recovered in smears on successive days after insemination may be due to two factors, namely, the ingestion of sperm by ameboid cells in the ovary, as found in *Glaridichthys* (Philippi, 1909), and the concentration of sperm in the folds of the oviduct reported by Philippi (1909) in *Glaridichthys* and in the folds of the ovary as seen in the histological studies of Winge (1922) and Stepanek (1928) on *Lebistes*.

Discussion.

Female Behavior.

One of the most striking aspects of the act of sperm transfer is the receptive stance of the female at the moment of contact with the male. Although at most other times the female flees from the male, there are periods —which may be very brief—when the female halts in her agitated swimming and remains stationary while the male copulates with her.

TABLE 7.

Sperm Recovery from Female Guppies.[1]

Female	*Number of Sperm in Smear on Varying Days After Insemination*			
	1 Day	*7 Days*	*11 Days*	*14 Days*
1A		40		10
3A		200		0
4A		20		0
5A		50		0
9		0		
12A		300		10
13A		500		2
21			0	
22			0	
23	>1000		80	6
24	>1000		0	
27	>1000	30	0	
30	>1000	10	0	
31				0

[1] Numbers over 10 are approximations of the number of sperm in the saline smear drop.

TABLE 8.

Sperm Recovery from Females Kept with Males in Community Tanks.

Date	Tank Size at Water Level: *Dimensions in cm.*[1]	Tank Size at Water Level: *Capacity in liters*	*Approximate Number of Fish in Tank*[2]	*Number of Females Tested*	*Number of females having smears with:* *Thousands of Sperm (Milky Drop)*	*Hundreds of Sperm (Clear Drop)*	*Few Dozens of Sperm*	*Less than 10 Sperm*	*No Sperm*
2/25/50	38 × 31 × 20	23.6	38	19	3	6	2	3	5
3/17/50	460 × 76 × 41	1430.0	>500	20	2	4	2	1	11
4/28/50	182 × 81 × 66	970.0	>200	15	1	1	5	3	5
			Total	54	6	11	9	7	21
Estimated last insemination before smear					1 day	2 to 7 days		> 7 days	

1 Measurements given in length, width and height respectively.
2 Figure given is for adults only; numerous young were also present.

We have observed this receptive behavior not only in virgin females placed together with mature males for the first time (groups I and II), but also in sexually experienced females, raised to adulthood in the presence of males except for the short isolation period of approximately two weeks before observations were begun on them (group III). In rodents and other mammals where sexual behavior has been studied most extensively, female mating behavior generally consists of one or more *positive* overt acts (Young, 1941). In the guppy the female mating pattern is primarily a *negative* response; that is, remaining stationary and failing to move away from the male. This, however, does not lessen the significance of this behavior. This situation is by no means unique for the guppy. Thus in the platyfish and in the swordtail an important feature of the female pattern is a similar failure to move away from the male at crucial periods. In these fish, however, this stance of the females is not as pronounced as in the guppy and once contact is made the copulating pair may move along, particularly during the more protracted contacts of the swordtail (Clark, Aronson & Gordon, in press).

In *Poecilia vivipara* and *Micropoecilia parae*, Haskins & Haskins (1949) state that the female responds to the actual gonopodial contact of the male by halting momentarily in her swimming and thereby rotating her body slightly towards the side from which the male has approached. In the leopard frog, *Rana pipiens*, and the green frog, *Rana clamitans*, receptivity is likewise a *negative* response (Noble & Aronson, 1942; Aronson, 1943). In the unovulated or spent female frog, the audible warning croak is the stimulus which causes the male to release his clasp. The ovulated female (i.e., one ready to lay her eggs) does not emit the warning croak when clasped by the sexually active male. This is clearly a receptive response. In sheep, according to McKenzie & Terrill (1937), there are no reliable indications of heat until the estrous female is teased by the ram whereupon she will stand and allow the ram to mount. When not in heat, the ewe will move away quickly when teasing action starts. From the review of Young (1941) it is clear that in many other mammals the failure to move away or resist the approaches of the male is the receptive behavior of the female. This behavior is often discriminative and selective.

In contrast to our results, most of the published discussions on sexual behavior in the guppy state that during the courtship the female constantly flees from the male, and when he does contact her, it is by taking her "unawares." From our results, it would seem that none of these authors had seen or recognized a true copulatory act. An exception to this general misconception concerning the behavior of the female during copulation was expressed somewhat indirectly by Stepanek (1928) who believed it possible

that the female responded to the male by closing [the sphincter of the genital aperture?] over the inserted tip of the gonopodium. It is possible that this theory is based on observations of the receptive stance of the female.

Certain of Jaski's statements (1939) concerning the sexual behavior of the female guppy may now be considered. Jaski described an estrous cycle in the guppy which is reflected by changes in the angle at which the female swims. In view of Jaski's reports we particularly took notice of the swimming and resting angle of those females that did and those that did not copulate. However, we did not observe any significant correlations between these features of behavior.

Jaski also reported that virgin females first introduced into aquaria with males did not come into estrus for 3 to 4 days. Hence, according to him, it was practically impossible to mate them for several days due to their non-receptivity. Our observational records show that virgin females may readily mate on the day they are first paired with males (see females A-2 and D-3 in group I; females 13 and 15 in group II). Three other virgin females that were paired overnight to test fertility of males also became inseminated in this time. In fact, some of our females (group I) copulated within a few minutes after their first contact with males. Before their first pairing, our virgin females were not exposed to water in which male guppies had lived and hence could not have been under the influence of what Jaski calls "copulin," the female-stimulating hormone supposedly secreted by the male guppy. However, we followed the standard aquarium practice of using "fish-conditioned water" obtained from large stock tanks of the cichlid fish *Tilapia macrocephala*. It is well known among aquarists that when some aquarium fish are introduced into tap water or standing water in which no plants or animals have lived for some time, they may suffer from a shock-like condition. Sometimes they survive, but it may often take a day or more to recover completely. It is possible that Jaski's results may be explained in part by a generalized water conditioning effect instead of the specific sexual secretion that he postulates. Dr. Breder states (personal comunication) that he tried to repeat some of Jaski's experiments. Breder used tap water which he conditioned with plants before introducing the fish. Under such circumstances the fish showed no signs of distress when first placed in the aquaria used for his tests, and the females showed no cyclical variation in the swimming angle as reported by Jaski. Breder states further that, in his experience, only sick guppies assume other than the normal resting or swimming position.

Our studies suggest that some females are more receptive at some times than others. In some of our observations the female consistently swam away from the male or rested on the bottom of the tank so that the male could not bring the gonopodium close to her genital region at any time in the entire observation period, which in several cases (group II) lasted for over an hour. In other cases, the constant fleeing behavior of the female appeared to prevent copulation even though considerable jabbing took place. In still other cases, copulations occurred within one or two minutes after the pair had been placed together. Whether receptivity in the female guppy is a cyclical physiological phenomenon, or a state which results from more immediate environmental conditions, or both, remains to be determined.

Male Behavior.

It can be seen from this study that the male guppy inseminates the female only during the copulatory act which involves a definite contact between the tip of the male gonopodium and the female genital region. During these copulations the female remains stationary while the male pushes against her with his gonopodium. The contact may be very brief, or may last several seconds. The male's numerous non-contact jabs and contact jabs at a fleeting female, so commonly observed in aquaria of mixed sexes of guppies, are not acts of insemination as reported by many authors.

Breder & Coates (1935) raised the question why frequent inseminations take place in the guppy, especially when it is known that isolated females, for months after a single insemination, may continue to drop broods — as many as eight, according to Winge (1922, 1937). Actually, as we have shown by both observational methods and by smear tests of females from community tanks, actual inseminations occur relatively infrequently and the "large wastage of sperm" is not as great as these authors suspected. In reality, females are rarely inseminated more than a few times a week if that often (Table 7). Relative to the number of young produced, the amount of sperm expended by the guppy may well be no greater than in many other vertebrate species.

A limited number of reinseminations may have considerable adaptive significance. When poeciliid females are isolated shortly after one or more inseminations, the size of brood tends to decrease in the ensuing series of roughly monthly parturitions (Breder & Coates, 1932; Breider, 1934). On the other hand, in females that are constantly being reinseminated, the size of brood remains large. Moreover, according to Philippi (1909), Van Oordt (1928) and Breider (1934), isolated females may temporarily discontinue dropping broods, especially during winter months.

The first four males in group II (nos. 1, 2, 5 and 6) were sexually inexperienced males that had been segregated from females at the time their gonopodia started to differentiate. As can be seen from Table 2, these

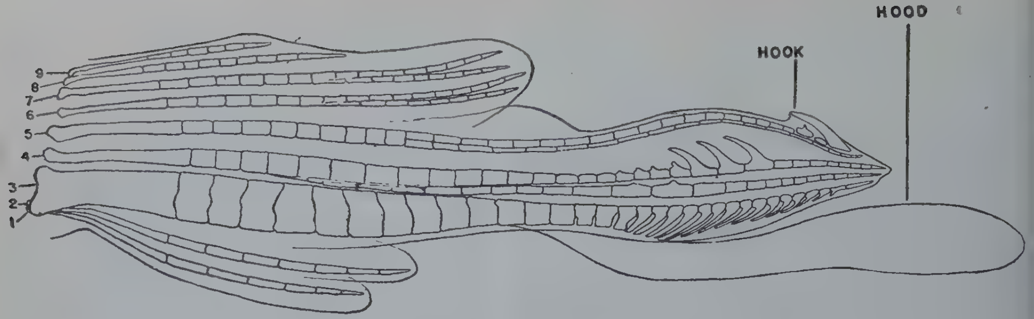
males did not thrust or copulate. Breder & Coates (1935), Noble (1938), Haskins & Haskins (1949), and Clark, Aronson & Gordon (In ms.) have all emphasized the role of learning in the selection of mates. It seems plausible, therefore, that the failure of these virgin males to thrust or copulate may be attributed to their lack of previous courtship and copulatory experience.

Haskins & Haskins (1949), in a revealing study of sexual selection in the guppy, introduced experienced male *Lebistes* into a tank containing one female *Lebistes*, one female *Micropoecilia* and one female *Poecilia*. Gonopodial contacts were counted and it was found that shortly after their introduction, the greatest percentage of the contacts were with the *Micropoecilia* female. After being left together for one week, the contacts were almost all with the *Lebistes* female. In a similar experiment these authors showed that this adjustment to the *Lebistes* female is completed in three days. The discrimination involved, according to Haskins & Haskins, is based essentially on the behavior of the males, and gives some evidence of being a learned reaction. It seems fairly clear from their descriptions of the mating process that these authors were really counting jabs, and that copulations did not occur during their observation periods. This is indicated especially by our finding that fish in community tanks are not likely to copulate within an even lengthy observation period. However, the counting of jabs rather than actual inseminations does not necessarily detract from the importance of the findings of both Breder & Coates (1935) and Haskins & Haskins (1949) relative to sexual discrimination in the guppy, as there may very well be a high correlation between courtship behavior and ability and opportunity for copulation. Our data on gonopodium swinging suggest such a correlation. In observations where copulations occurred, the mean number of swings was significantly higher than in observations in which copulations did not occur. On the other hand, significant differences were not found in the mean frequencies for S-curving and thrusting between observations where copulations did and did not occur. It should be noted, however, that the relationship between courtship and copulation is made somewhat obscure by the fact that the most highly excited males will copulate with few or no preliminary acts. Thus it seems that the sexually least excited as well as the most excited males will have the lowest courtship scores while the high scores for these activities are for the most part a reflection of the responsiveness of an intermediate group of males. Since in the previously mentioned studies on sexual selection in the guppy, thrusting behavior was used as the major criterion for a differential reaction to the opposite sex, and since we have shown that thrusting does not result in insemination, it becomes increasingly important for future studies to determine more exactly the relation of thrusting to copulation.

The Function of the Gonopodium.

Just how the gonopodium of poeciliid fishes functions in the transfer of spermatophores from the male to the female during copulation has long been a subject for speculation. It has been suggested that in the guppy the pelvic fins are rotated forward with the gonopodium during "coitus" (Purser, 1941) in such a manner that the tips of the pelvic fins (which in the male are modified elongations of the second rays) are slipped into the hood, thus forming a tube-like structure through which the sperm are shot out at the female (Fraser-Brunner, 1947). Vaupel (1929) proposed that the hood may be inserted and then expanded within the female genital aperture, thus permitting the entrance of spermatophores. Christman (1928) reported that during gonopodial contact only one pelvic fin is brought forward. Our observations confirm those of Christman. We have found that during swinging, thrusting, and copulation, one pelvic fin is brought forward and that it is always the one on the side towards which the gonopodium is swung (Plate V). Thus an enclosure is formed into which the spermatophores are ejaculated and directed towards the female. The hood is too small and transparent to be seen readily during behavioral observations, but our photographs of guppies while swinging and thrusting, taken with an electric flash unit (Plates I through V) show the hood dangling loosely. In view of its soft and flabby structure it is therefore very doubtful that during copulation the hood either holds the tip of the pelvic fin as Fraser-Brunner reported (1947) or is inserted into the genital opening as Vaupel suggested (1929). Moreover, our data on amputation and Sengün's (1949) regeneration experiments show clearly that this structure is not necessary for effective insemination. The histological examination of the hood has demonstrated a large number of nerve fibers extending to the tip where there is an extensive nerve plexus. Since the structure contains no muscles, and few glands, it is presumed that these nerves are mostly sensory, and that the gonopodial hood is primarily a sensory organ. Although our experiment revealed that amputation of the hood does not interfere with insemination, it should be noted that we used only sexually experienced males. It may be of considerable interest to repeat the above experiment using inexperienced males and observational procedures.

An examination of the morphology of the gonopodium (Text-fig. 1) reveals that the most basic and elaborate components are rays 3, 4 and 5. Our experimental results after ablating the distal ends of these rays confirm the findings of Sengün and the views expressed by most authors, namely, that these rays are indispensable for sperm transfer. Stepanek stated that the distal com-

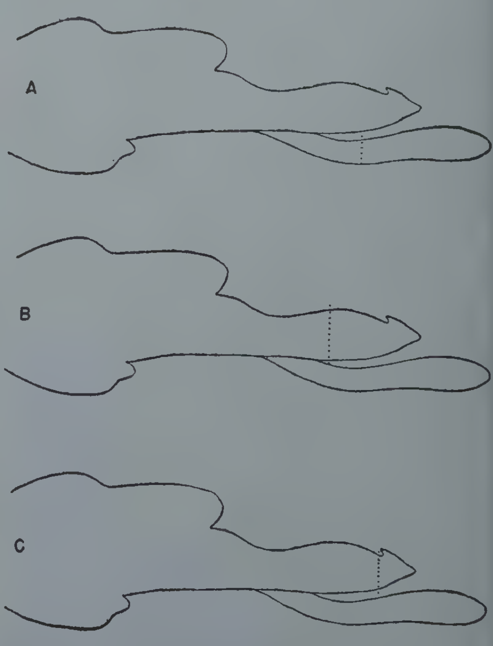


TEXT-FIG. 1. Gonopodium of a mature male *Lebistes reticulatus*. × 22.

ponents, especially the hook on ray 5, was necessary for the grip of the male on the female, which he believed occurred during copulation. Sengün, however, showed that males with abnormally regenerated gonopodia and lacking this hook, are able to inseminate females. Our results indicate that the absence of the tip of rays 3, 4 and 5 which includes this hook and other modified serrae-like ray segments may prevent copulation. But as Sengün's studies indicate, the gonopodia may again become functional after an abnormal regeneration of this region.

In *Platypoecilus maculatus* and *Xiphophorus hellerii*, the tip of the gonopodium is differentiated into an arrowhead-shaped structure. It consists of hooks and serrae highly suggestive of a holdfast organ; the hood, however, is lacking. In these species insemination occurs only during a pronounced copulatory act during which the pair appear hooked together and may even swim around the tank in close contact. Copulation in these fishes ends in a pronounced snap-like break as the fishes appear to pull away forcibly from each other (Clark, Aronson & Gordon, In ms.). In *Lebistes* the hooks and serrae on the tip of the gonopodium are not nearly so prominent. Our observations lead us to believe that during copulation the male and female guppies are not hooked together as in the platyfish and the swordtail; rather, contact is maintained by the male who actively swims and pushes against the stationary female. This is most easily observed during the long copulations. Moreover, since the male and female are not hooked, the termination of copulation is not accompanied by any sharp, snap-like break. It is not surprising therefore that copulation in the guppy is not usually as pronounced and as easily recognized as in either the platyfish or swordtail. Dr. Haskins, in a personal communication, has informed us of an unusual case where a pair of guppies were found attached to each other in one of his aquaria. At the time they were discovered the male was dead and the tip of his gonopodium was firmly hooked to the genital region of the female (Plate VII, Fig. 14). We believe that the actual attachment which occurred here represents an abnormal situation resulting, perhaps, from an atypical gonopodium.

Gonopodial function evidently shows some important differences among viviparous cyprinodonts. In *Horaichthys* the gonopodium-like anal fin is greatly modified, particularly the distal segments of rays 4 and 5 (Kulkarni, 1940). However, these modifications are of a very different nature from *X. hellerii*, *P. maculatus* or *L. reticulatus*. Horn-like, spoon-shaped, conical, and attenuated processes are conspicuously developed, and except for a small hyaline recurved hook on the inner wall of the tubular portion of ray 5, there are no conspicuous hooks or serrae. Kulkarni observed mating in this fish. By examining females for sperm (which are packed in spermatophores embedded in the tissue around the female genital papilla) after his observations, he discovered that spermatophores are transferred to the female during a momentary contact. As the male "approaches his mate, he lashes out the gonopodium sideways almost at right angles to his body and strikes its terminal end



TEXT-FIG. 2. Outline drawings of *Lebistes* gonopodia. Broken lines indicate levels at which amputations were made. A, B, and C correspond to groups designated in Table 6.

against her genital opening" in what we would probably term a contact thrust or possibly a short copulation.

It thus appears that in the various cyprinodonts the gonopodia function in quite different fashions. Their customary designation as "intromittent organs" is misleading. The highly differentiated and complex gonopodia of most cyprinodontid fishes are indeed remarkable structures. Although gonopodial morphology has been studied in great detail, especially for taxonomic (Regan, 1913) and genetic (Sengün, 1949; Gordon & Rosen, 1951) purposes, little is known concerning the reproductive behavior of most of these cyprinodonts. However, on the basis of our present knowledge one could expect to find a definite correlation between gonopodial structure and function. Hence further comparative studies of cyprinodont sexual behavior and gonopodial morphology coupled with experimental methods involving various types of gonopodial ablations should reveal far more valuable information.

Summary and Conclusions.

1. A review of the scientific and popular literature reveals many interesting and controversial ideas concerning the mechanisms of sexual behavior of the guppy, particularly in regard to the act of insemination.

2. In a series of observational studies and experiments, various courtship patterns were analyzed, particularly the behavior of the male which we called gonopodial swinging, body curving, thrusting and copulation.

3. By the use of a genital smear technique, it was possible to detect the presence of sperm in females several days after insemination. By taking smears on females immediately after observations it was learned that actual inseminations are relatively infrequent. Inseminations occur during definite and recognizable types of contacts (copulations) between the male and female when the latter specifically halts in her swimming. Inseminations were not effected during the commonly observed non-contact and momentary contact thrusts.

4. The action and function of the gonopodium was analyzed. During swinging, thrusting and copulation the gonopodium is brought forward and to one side, together with a forward movement of one of the pelvic fins. The gonopodial hood is not necessary for insemination. The presence of large numbers of nerve fibers and the extensive plexus at the tip of the gonopodial hood suggests that it serves primarily in a sensory capacity. The absence of the distal segments of rays 3, 4 and 5 hinders and may completely prevent sperm-transfer to the female.

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EXPLANATION OF THE PLATES.

Plate I.

Action of the gonopodium at the beginning of swinging behavior.

Fig. 1. Gonopodium in resting position (pointing caudally). The arrow points to the gonopodial hood.

Fig. 2. Gonopodium at the beginning of a "swing" is moving ventrally away from the body of the fish.

Fig. 3. Gonopodium moving forward and to left side; note position of left pelvic fin which is also moving forward. The dorsal fin often remains folded at this stage.

Plate II.

Action of the gonopodium at the height of swinging behavior.

Fig. 4. The gonopodium is now forward and on the left side of the fish. The left pelvic fin is also forward and the dorsal fin is erected. Arrow points to gonopodial hood.

Fig. 5. A slightly more advanced stage of the preceding picture. The pelvic fin is completely forward.

Fig. 6. The gonopodium is far forward. It appears braced against the pelvic fin. The gonopodial hood (arrow) still dangles loosely on the dorsal margin of the gonopodium now that the latter has been swung through a 180° arc. The body of the fish is arching upwards. This is a picture of a swing to the right.

Fig. 7. The peak of a swing on the left side of the fish showing the body twisted into an "S" shape.

Plate III.

Thrusting behavior.

Fig. 8. A male (left) approaching a female from above and thrusting at her.

Fig. 9. A male (left) approaching a female from the side and thrusting.

Plate IV.

Thrusting behavior.

Fig. 10. A male (right) in position to make a contact thrust. Female's body is straight but male's body is curved and tilted toward female.

Fig. 11. A male (right) in position just before or after a contact thrust. The female is tilted away from the male but his gonopodium is still within reach of her genital region.

Plate V.

Fig. 12. A male approaching the right side of the female for a thrust. Gonopodium and left pelvic fin are being brought forward in the same manner as in swinging behavior.

Plate VI.

Fig. 13. The same male as in Plate V, approaching the other side of the female. The gonopodium and pelvic fin are completely forward. Note the gonopodial hood (arrow) which in this picture appears dark.

Plate VII.

Fig. 14. Unusual case where the gonopodium of a dead male was found firmly hooked to the gential region of the female. Courtesy of Dr. Caryl P. Haskins.

Fig. 15. Transverse section through the proximal portion of the gonopodial hood. Haematoxylin and eosin × 410.

Fig. 16. Transverse section through the middle of the gonopodial hood. Haematoxylin and eosin × 410.

Fig. 17. Transverse section through the distal tip of the gonopodial hood. Haematoxylin and eosin × 480.

Fig. 18. Whole mount of tip of gonopodial hood showing nerve plexus. Large black dots are melanophores. Methylene blue × 280.

Abbreviations:

- c. = concavity of hood
- ca. = caecum
- ep. = epithelium
- co. = core
- c.m. = core membrane
- c.t. = connective tissue layer
- l.b.v. = major left blood vessel (carries blood proximally)
- r.b.v. = major right blood vessel (carries blood distally)
- m. = melanophore

FIG. 1.

FIG. 2.

FIG. 3.

SEXUAL BEHAVIOR IN THE GUPPY, LEBISTES RETICULATUS (PETERS).

FIG. 4.

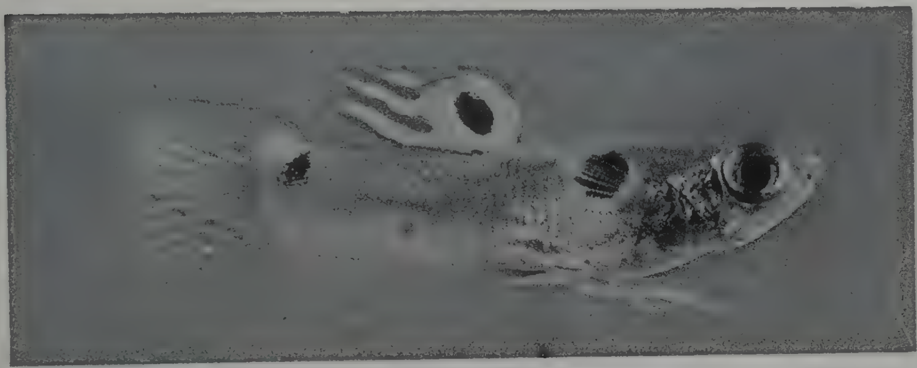

FIG. 5.

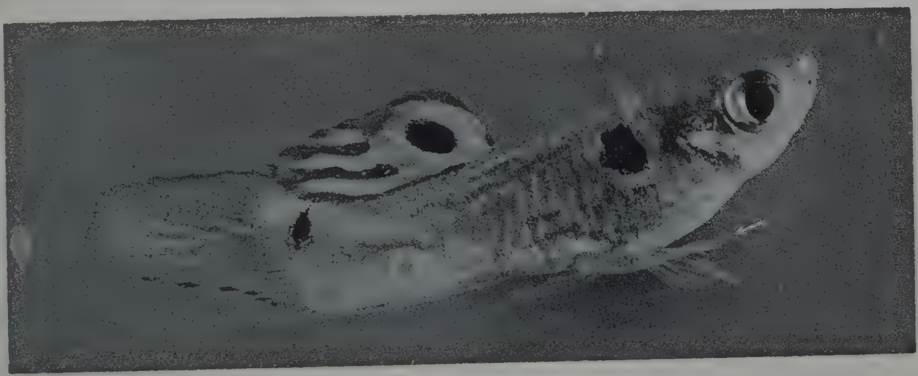

FIG. 6.

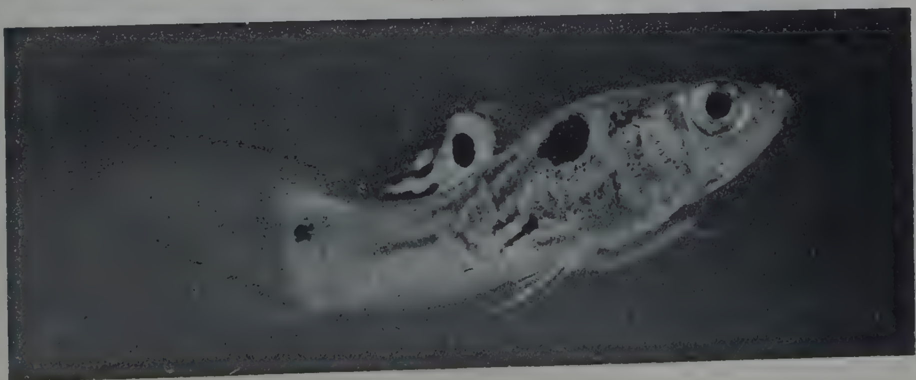

FIG. 7.

SEXUAL BEHAVIOR IN THE GUPPY, LEBISTES RETICULATUS (PETERS).

FIG. 8.

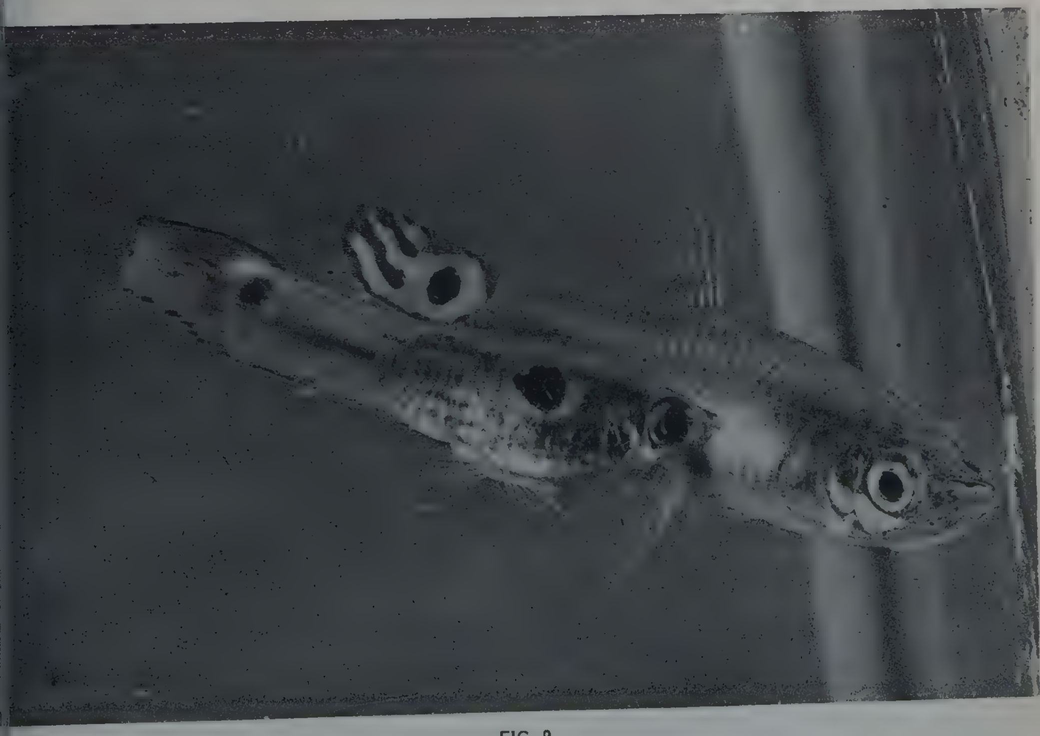

FIG. 9.

SEXUAL BEHAVIOR IN THE GUPPY, LEBISTES RETICULATUS (PETERS).

FIG. 10.

FIG. 11.

SEXUAL BEHAVIOR IN THE GUPPY, LEBISTES RETICULATUS (PETERS).

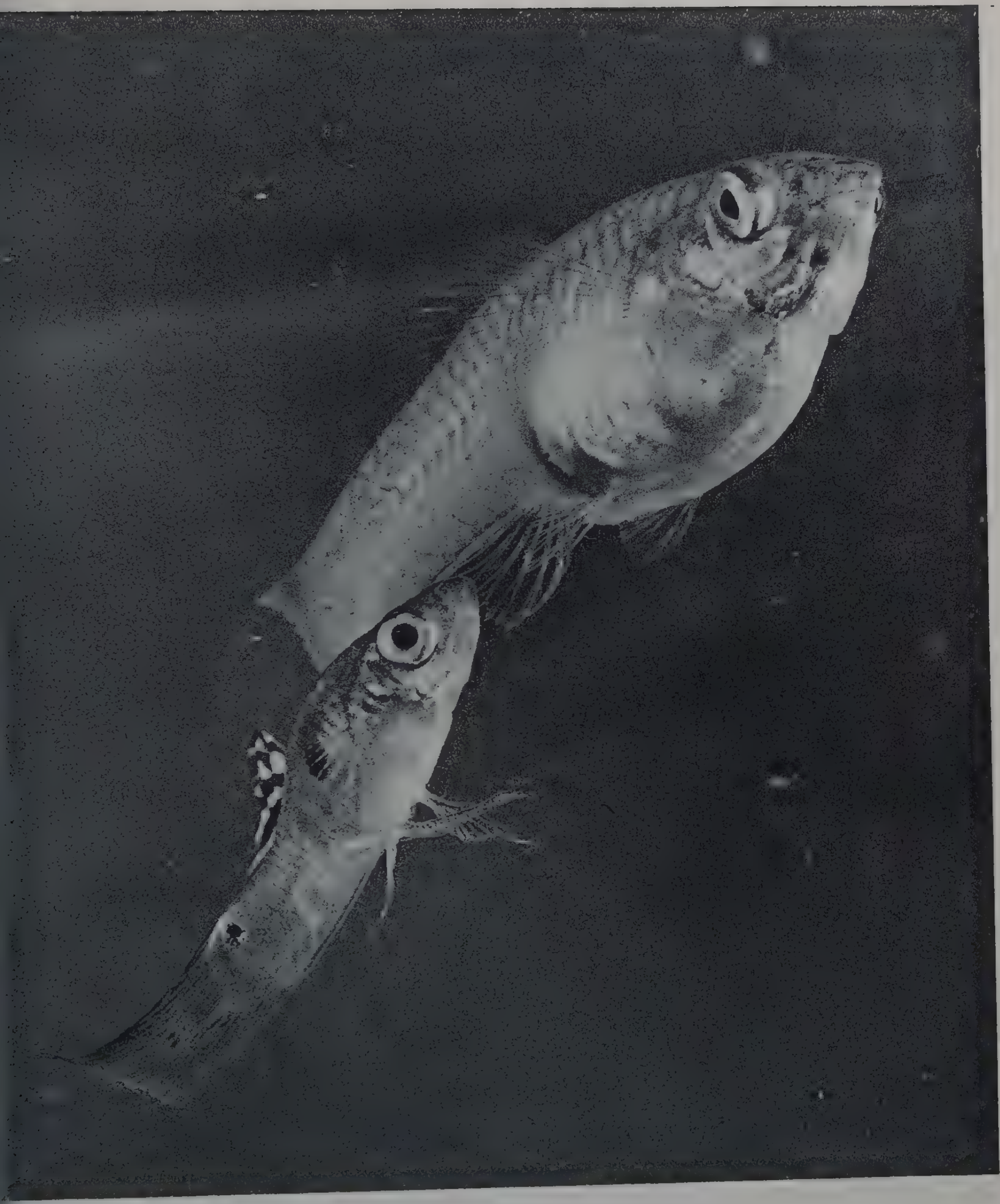

FIG. 12.

SEXUAL BEHAVIOR IN THE GUPPY, LEBISTES RETICULATUS (PETERS).

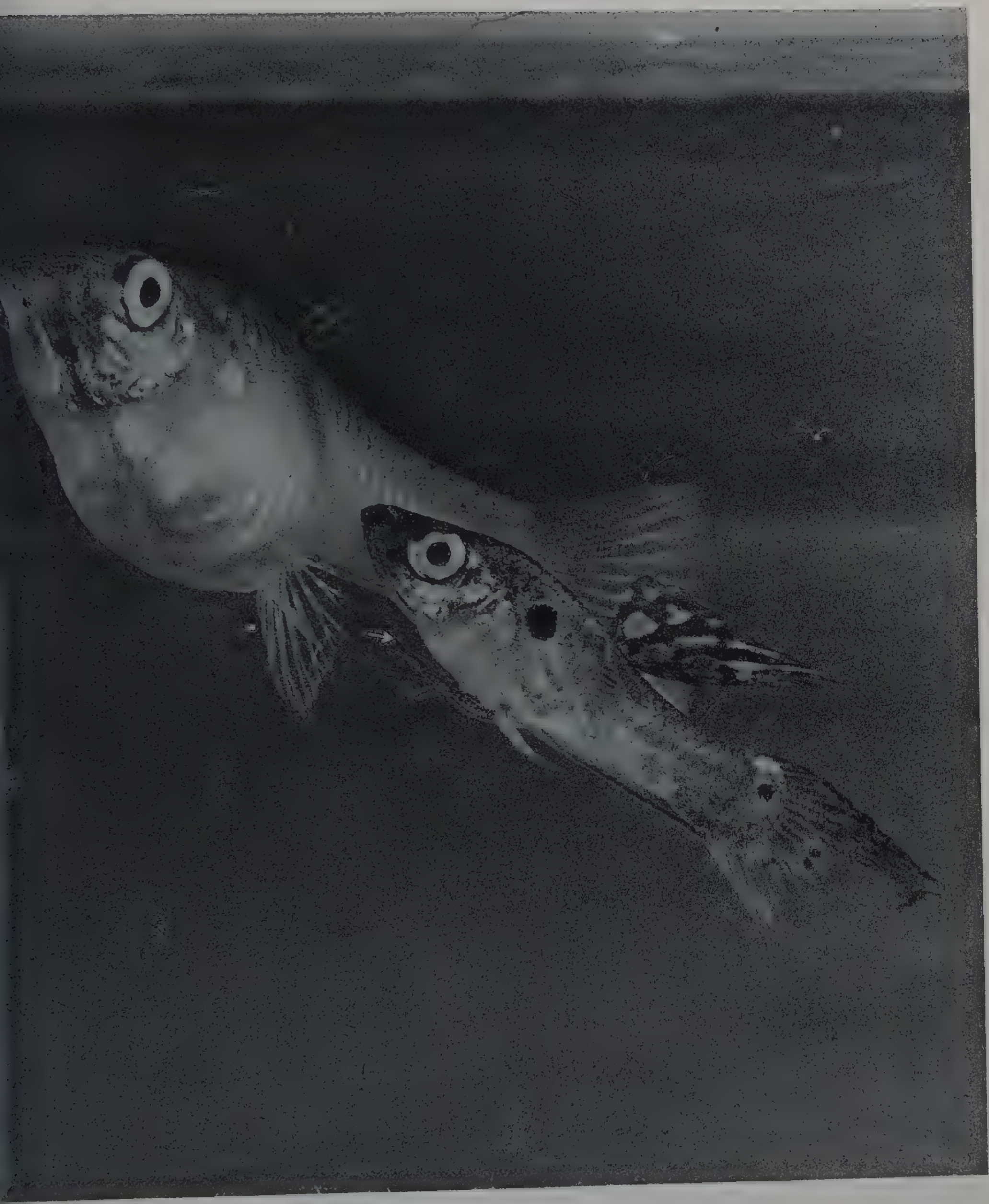

FIG. 13.

SEXUAL BEHAVIOR IN THE GUPPY, LEBISTES RETICULATUS (PETERS).

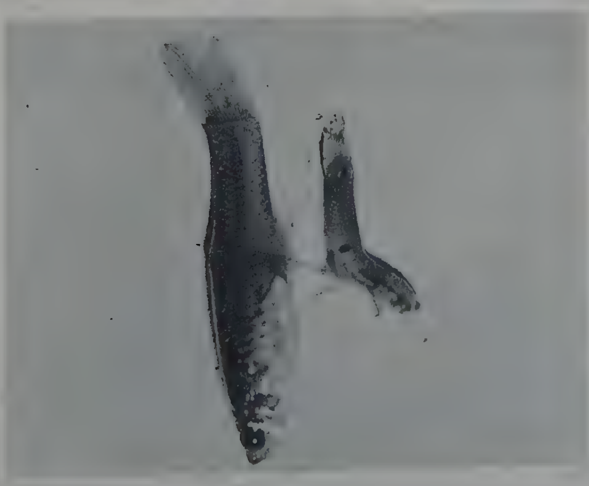

FIG. 14.

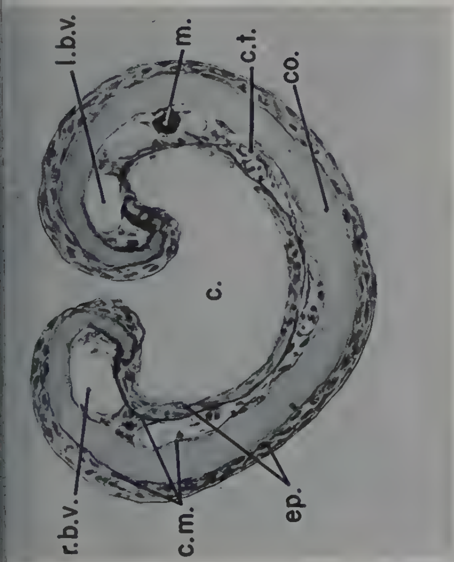

FIG. 15.

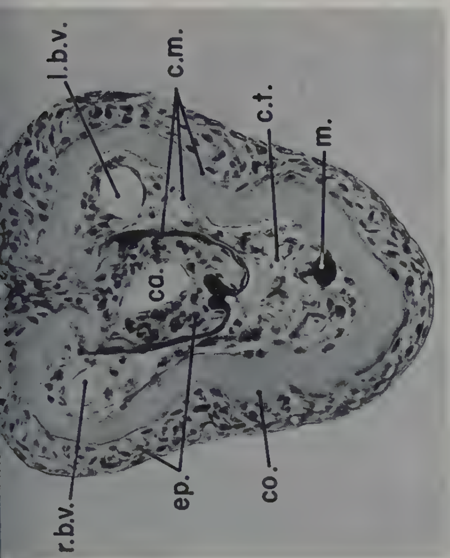

FIG. 16.

FIG. 17.

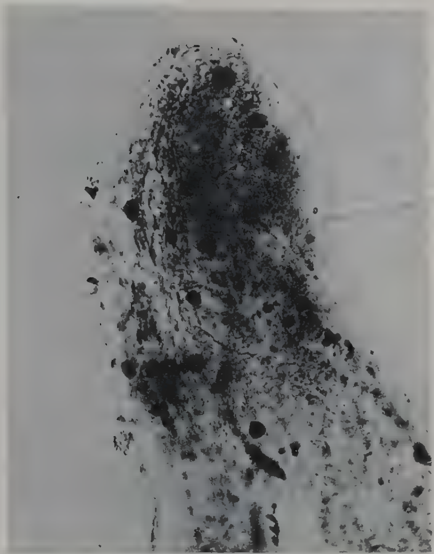

FIG. 18.

SEXUAL BEHAVIOR IN THE GUPPY, LEBISTES RETICULATUS (PETERS).

5.

Eastern Pacific Expeditions of the New York Zoological Society. XLIII. Mollusks from the West Coast of Mexico and Central America. Part X.[1]

LEO GEORGE HERTLEIN & A. M. STRONG.
California Academy of Sciences.

(Plates I-XI).

[This is the forty-third of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of William Beebe. The present paper is concerned with specimens taken on the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). For data on localities, dates, dredges, etc., refer to *Zoologica*, Vol. XXII, No. 2, pp. 33-46, and Vol. XXIII, No. 14, pp. 287-298].

CONTENTS.

[1] Contribution No. 895, Department of Tropical Research, New York Zoological Society.

Introduction.

This is the tenth and final part of the series of papers published in *Zoologica* dealing with the mollusks collected during the Eastern Pacific Expeditions of the New York Zoological Society, 1936, 1937-1938. Parts I-IX dealt with the Pelecypoda collected on those expeditions. These appeared as follows:

Part	Volume	Part	Number	Pages	Plates	Date
I	25	4	25	369-430	1, 2	December 31, 1940
II	28	3	19	149-168	1	December 6, 1943
III	31	2	5	53- 76	1	August 20, 1946
IV	31	3	8	93-120	1	December 5, 1946
V	31	4	10	129-150	1	February 21, 1947
VI	33	4	13	163-198	1, 2	December 31, 1948
VII	34	2	9	63- 97	1	August 10, 1949
VIII	34	4	19	239-258	1	December 30, 1949
IX	35	4	19	217-252	1, 2	December 30, 1950

This paper deals with the new species of Scaphopoda, Gastropoda and Amphineura collected during the Eastern Pacific Expeditions of the New York Zoological Society, 1936, 1937-1938. Originally it was planned to publish references to and descriptions or notes dealing with all of the species of gastropods and scaphopods occurring in tropical west American waters. Conditions resulting from unsettled international relations caused changes in this plan as mentioned in Part II of this series of papers. Accordingly, manuscript was prepared dealing with the species obtained during the expeditions of 1936, 1937-1938. The increased cost of publication as well as the desirability of publishing the results of other expeditions and projects of the New York Zoological Society have led to the necessity of closing this series of papers in *Zoologica* with Part X. This paper is limited almost entirely to the descriptions of new species. The description of the single new species of chiton, *Ischnochiton crockeri*, was prepared by the late George Willett. It is planned that additional papers dealing with tropical west American marine mollusks will be published in other periodicals from time to time. Three such papers[2] have recently appeared.

In completing this series of papers the authors wish to express their appreciation to the many persons and institutions who have aided them in this work. The late Templeton Crocker, owner of the Yacht *Zaca* during the expeditions on which the collections here described were assembled, cooperated and maintained a strong interest in the work. Our thanks are here extended to Dr. William Beebe whose unfailing cooperation and interest have inspired the authors throughout this work. We wish to reiterate our statement in Part I, namely, that his collecting and recording of locality information is a model of its kind. Also we extend our thanks to Mr. William Bridges, Curator of Publications of the New York Zoological Society, who has at all times shown the utmost cooperation and patience in seeing the publications through the press. Dr. G. Dallas Hanna, Curator of the Department of Paleontology, California Academy of Sciences, and Mr. A. G. Smith, Research Associate of the same institution, have aided us whenever called upon during our work on these papers. Acknowledgment also is due those persons who have aided us by the loan of specimens, indentification of species, or in other ways. These include Dr. A. Myra Keen, Stanford University; Dr. Harald A. Rehder, U. S. National Museum; Miss Viola Bristol, San Diego Society of Natural History; Dr. Wm. M. Ingram, Mills College. Occasionally books for reference purposes were made available by authorities of the University of California, the University of California at Los Angeles, The John Crerar Library and the Library of Congress.

The photographs used to illustrate the species represented on the plates of this paper were made by Mr. Frank L. Rogers. The authors wish to express their appreciation to officials of the American Philosophical Society for a grant-in-aid[3] to the senior author which was made available to defray the expense of photography incidental to the present paper. We also wish to express our appreciation to Mrs. Georgia Fitzsimmons for careful secretarial work on the manuscript.

Class Scaphopoda.

ORDER SOLENOCONCHA.

Family Dentaliidae.

Genus *Dentalium* Linnaeus.

Subgenus *Rhabdus* Pilsbry & Sharp.

Dentalium (Rhabdus) cedrosense Hertlein & Strong, sp. nov.

Plate XI, Fig. 9.

Shell nearly straight and extremely slender, thin, glossy, white, circular in section; apex very gently curved, truncate, without notch, slit or apical tube; shell sculptured with a few fine longitudinal lines which are visible under moderate magnification and

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[2] Hanna, G. D., & Strong, A. M. West American mollusks of the genus Conus. *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 26, No. 9, January 28, 1949, pp. 247-322, pls. 5-10, 4 text-figures.

Hertlein, L. G., & Strong, A. M. Description of a new species of Trophon from the Gulf of California. *Bull. South. Calif. Acad. Sci.*, Vol. 46, Pt. 2, May-August, 1947, issued February 5, 1948, pp. 79-80, pl. 18.

Strong, A. M. Additional Pyramidellidae from the Gulf of California. *Bull. South. Calif. Acad. Sci.*, Vol. 48, Part 2, May-August, issued November 4, 1949, pp. 71-93, pls. 11, 12.

[3] For report on Grant No. 1078, see The American Philosophical Society Yearbook 1949, issued 1950, pp. 147-148.

cross lighting; posterior half of shell ornamented with a series of low, close-set concentric, rounded ridges which gradually fade out toward the anterior smoother half. Dimensions of the type: Length, 9 mm.; diameter at aperture, .24 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 126-D-12, Lat. 28° 20′ 00″ N., Long. 115° 10′ 30″ W., a mile off the east coast of Cedros Island, Lower California, Mexico, in 45 fathoms (82 meters), crushed shell and mud; collected by the Templeton Crocker Expedition, May 22, 1936.

This species is similar to *Dentalium rectius* Carpenter[4] but that species (as well as all others from the west coast comparable in size and shape), lacks the concentric sculpture which is so obvious on this one.

Two specimens of this species were dredged by the Templeton Crocker Expedition, 1932, in Lat. 23° 03′ 00″ to 23° 06′ 00″ N., Long. 109° 36′ 00″ to 109° 31′ 00″ W., in 20-220 fathoms.

It seems quite possible that the new species described here may be referable to the subgenus *Episiphon* Pilsbry & Sharp because of the presence of sculpture consisting of strong annular rings on the posterior portion of the shell. According to Pilsbry & Sharp, some of the species of the subgenus *Rhabdus* possess numerous low variceal annular swellings. The apex of shells referred to *Episiphon* usually possess a short projecting tube or a wide shallow U-shaped lateral notch. However, Pilsbry & Sharp mentioned that the apex of shells of this subgenus may be . . . "simple or notched apex, or truncate with a supplemental apical tube." Woodring[5] stated with regard to this subgenus "The apical tube, which may not be a feature of biologic significance, is absent even on many specimens of the type species and is not confined to species included in this subgenus. Most of the living species of *Episiphon* are deep-water dwellers." The absence of a tube or notch on the apex of the present species, as well as the habitat in comparatively shallow water, has led us, at least for the present, to place the present species in the subgenus *Rhabdus*.

Family Siphonodentaliidae.

Genus **Cadulus** Philippi.

Subgenus **Platyschides** Henderson.

Cadulus (Platyschides) austinclarki Emerson.

Plate XI, Figs. 1, 6.

Cadulus (*Platyschides*) *austinclarki* Emerson, *Jour. Washington Acad. Sci.*, Vol. 41, No. 1, January 15, 1951, p. 24, figs. 1, 2. "Santa Inez Bay, Baja California (Gulf of California), west around Santa Inez Point, dredged in 6-12 feet of water in fine black sand." Also other localities.

Type Locality: Santa Inez Bay, Lower California, Mexico, in the Gulf of California, in 6-12 feet, black sand.

Range: Santa Maria Bay, west coast of Lower California to Santa Inez Bay in the Gulf of California and south to Panama City and the Galapagos Islands.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (145-D-1, 3), 4-13 fathoms (7.5-24 meters), sand.

Description: Shell gently arcuate, the bend greater posteriorly, rather short and stubby, inflated in the central portion; translucent, glossy, with extremely faint concentric and longitudinal lines; apertural end tapering gently to a diameter not more than a third larger than the apical opening, aperture oblique; apical margin with on some specimens 2, on others 4, notches on the ventral side and spaced about 75° apart. Dimensions of the hypotype: length, 4.05 mm.; diameter at aperture, 0.18 mm.; greatest diameter, 0.27 mm.; at the apex, 0.135 mm.

This species is smaller and much more inflated in the center than *Cadulus quadrifissatus* Carpenter in Pilsbry & Sharp[6]. A set of the latter in the California Academy of Sciences has been used for comparison since they probably are a portion of the original lot.

Cadulus (*Platyschides*) *austinclarki* was compared by its author with similar east American species. It is said to resemble *Cadulus* (*Platyschides*) *nitidus* Henderson (*U. S. Nat. Mus., Bull.* 111, 1920, p. 129, pl. 19, fig. 9), from Porto Rico, in apical features but differs in the shorter and less attenuated shell which also is more inflated at the equator. The general outline of the west coast species resembles that of *Cadulus* (*Platyschides*) *parvus* Henderson, from Florida and Barbados, but differs in that the shell is shorter and has less prominent apical features. The shell of *Cadulus* (*Platyschides*) *austinclarki* is less attenuated and less convex than that of *Cadulus* (*Polyschides*) *quitus* Pilsbry & Olsson[7] which was originally described from the Pliocene of Ecuador.

Distribution: A few specimens of this species were taken in Santa Inez Bay in the Gulf of California. It also has been reported as occurring at various localities from southern Lower California to Panama and the Galapagos Islands, in 1 to 4½ fathoms.

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[4] *Dentalium rectius* Carpenter, *Rept. Brit. Assoc. Adv. Sci.* for 1863 (issued August, 1864), pp. 603 [Nom. nud.], 648. Puget Sound and vicinity.—Carpenter, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 17, August 7, 1865, p. 59. "Hab.—In sinu Pugetiano legit Kennerley."—Pilsbry & Sharp, Man. Conch., Vol. 17, 1897, p. 113, pl. 21, fig. 45. Localities cited from Puget Sound to off Cortes Bank, California, in 13 to 984 fathoms.

[5] Woodring, W. P., *Carnegie Inst. Washington, Publ.* 366, May 20, 1925, p. 203.

[6] *C*[*adulus*]. *quadrifissatus* (Carpenter), Pilsbry & Sharp, Man. Conch., Vol. 17, May 3, 1898, p. 150, pl. 29, figs. 10, 11, 12, 13. "San Diego, California, 10 fms. (Henry Hemphill, in Acad. coll.); San Pedro (Smithsonian Institution)."

[7] *Cadulus* (*Polyschides*) *quitus* Pilsbry & Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 93, September 9, 1941, p. 48, pl. 10, figs. 9, 10. "Canoa formation, Punta Blanca." Ecuador. Pliocene.

Class Gastropoda.

ORDER OPISTHOBRANCHIATA.

FAMILY ATYIDAE.

Genus **Atys** Montfort.

Subgenus **Aliculastrum** Pilsbry.

Atys (Aliculastrum) liriope
Hertlein & Strong, sp. nov.
Plate VIII, Fig. 2.

Shell slenderly elongate-ovoid, shining, translucent, white; entire surface ornamented with fine, closely spaced spiral threads which are cut by equally fine but more widely spaced incised axial lines, toward the base the axial lines become fainter and the spiral cords broader; apex obliquely truncated, deeply, narrowly pitted, with both the axial and spiral sculpture entering the pit; aperture as long as the shell; outer lip rising from the edge of the pit with a rounded notch or sulcus partly reflected over it, above which the lip extends for a short distance before rounding sharply to form a narrow aperture along the body of the shell; columella curved, forming a broadening of the aperture, the edge broadly reflected over the umbilical region without a visible fold, the lower end extended downward to join the outer lip in a canal-like projection. Dimensions: length, 9.8 mm.; maximum diameter, 3.6 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station ?-D-27, probably from Station 136-D-27, Arena Bank, Gulf of California, Lat 23° 28′ 00″ N., Long. 109° 24′ 00″ W., dredged in 50 fathoms (91 meters), sand, calcareous algae, rock.

The outer lip in the unique type is imperfect but the general characters of the shell seem to be quite different from any species described from the west coast. It differs from *Atys chimera* Baker & Hanna[8] in the more uniform, closely spaced, raised sculpture, lack of columellar fold, and in a canal-like basal projection of the aperture. In shape the new species is more like *Cylichna fantasma* Baker & Hanna[9] which species, however, lacks the apical notch or sulcus.

ORDER CTENOBRANCHIATA.

Superfamily Toxoglossa.

FAMILY TURRITIDAE.

Genus **Carinodrillia** Dall.

Carinodrillia pilsbryi Lowe.
Plate I, Fig. 10.

Clathrodrillia pilsbryi Lowe, *Trans. San Diego Soc. Nat. Hist.*, Vol. 8, No. 6, March 21, 1935, p. 23, pl. 4, fig. 2. "Punta Peñasco, Sonora, dredged 10 fathoms (1934)."

Type Locality: Punta Penasco, Sonora, Mexico, in the Gulf of California, dredged in 10 fathoms.

Range: Punta Penasco, Sonora, Mexico, to Gorda Banks, in the Gulf of California.

Collecting Stations: Mexico: Santa Inez Bay, Gulf of California (143-D-1), 29 fathoms, mud, crushed shell, weed; off Arena Point, Lower California (136-D-14), 45 fathoms, mud; Gorda Banks, Gulf of California (150-D-8), 40-50 fathoms, muddy sand.

Description: Shell slender, acute, nucleus and first 3 postnuclear whorls whitish, the remainder brown; nuclear whorls 3, smooth, shining; postnuclear whorls 12, sutures closely appressed, with the narrow, spirally striated, anal fasciole immediately adjacent; axial sculpture of (on the last whorl 7) strong, swollen, nearly vertical ribs which do not cross the anal fasciole and fade out on the base; spiral sculpture of sharp threads, strongest on the tops of the axial ribs but not nodulous, of these 3 or 4 appear on the spire between the anal fasciole and suture with about 15 similar cords on the base and canal; aperture narrow, outer lip thin, serrated at the edge by the spiral threads, last axial rib not varicose; anal sulcus small, deep, rounded, with a small callus pile on the body; inner lip callous, with a sharp, raised edge along the canal, leaving a decided umbilical chink; canal fairly short, slightly recurved. The specimen illustrated measures: length, 34 mm.; maximum diameter, 11.5 mm.

This species resembles *Clathrodrillia callianira* Dall[10] but has fewer and more prominent axial ribs and lacks the cord-like subsutural band. It also seems to be larger for the same number of whorls, *C. callianira* being described as length 16 mm. with 8½ postnuclear whorls but shown with 10 postnuclear whorls in the original figure. Lowe's species is very similar to *Carinodrillia adonis* Pilsbry & Lowe[11] but possesses more numerous spiral ribs.

Distribution: A few specimens of this species were dredged at 3 localities in the Gulf of California in 29 to 50 fathoms.

Genus **Clathurella** Carpenter.

Clathurella erminiana
Hertlein & Strong, sp. nov.
Plate I, Fig. 8.

Shell small, slender, brownish; nuclear whorls 2½, smooth, swollen; postnuclear whorls 7, sutures appressed; first 3 whorls with 8 sharp nodes near the lower edge, on the fourth whorl these begin to become axially elongated with first 1 and then 2 spirally elongated ridges crossing the tops but absent

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8 *Atys chimera* Baker & Hanna, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 16, No. 5, April 22, 1927, p. 126, pl. 4, fig. 4. ". . . dredged in shallow water in Puerto Escondido, Lower California." Also off La Paz and in Coyote Bay, Concepcion Bay, east coast of Lower California.

9 *Cylichnella fantasma* Baker & Hanna, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 16, No. 5, April 22, 1927, p. 128, pl. 4, fig. 6. ". . . taken in Isthmus Bay, Espiritu Santo Island, Gulf of California." Also taken in San Gabriel Bay, Espiritu Santo Island and in San Luis Gonzaga Bay, Lower California.

10 *Clathrodrillia callianira* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 16, pl. 5, fig. 2. "Range.—Station 2823, off Lower California in 27 fathoms, sand, U. S. Bureau of Fisheries."

11 *Carinodrillia adonis* Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 45, pl. 2, fig. 2. "Manzanillo, Mexico, dredged in about 20 fathoms."

in the interspaces; on the last whorl there are 10 axial ribs extending from the anal fasciole to the canal, crossed by 5 spiral cords, strong on the tops of the ribs, faint in the interspaces, these are followed by 12 closely spaced spiral threads on the lower part of the base and on the canal; anal fasciole rather broad, marked by numerous, curved lines of growth; aperture narrow, outer lip thin at the edge, greatly thickened a short distance back by a strong varix, separated from the canal by a shallow internal depression, interior not dentate; anal sulcus small, deep, with a raised edge and small subsutural callosity; inner lip smooth, the edge not raised; canal rather short, hardly recurved. The type measures: length, 12.5 mm.; maximum diameter, 5.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 147-D-2, Lat. 26° 57′ 30″ N., Long. 111° 48′ 30″ W., off Concepcion Point, Santa Inez Bay, Gulf of California, in 60 fathoms (110 meters), mud, crushed shell. A second specimen was dredged at the same locality.

This species is quite similar to *Glyphostoma sirena* Dall[12] from the Galapagos Islands, but differs principally in the less distinct axial ribs, fewer spiral cords and in the color.

Genus **Fusiturricula** Woodring.

Fusiturricula armilda Dall.

Plate VIII, Fig. 4.

Turris (*Surcula*) *armilda* Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 262. "U.S.S. 'Albatross', station 3017, Gulf of California, off Cape Lobos, in 58 fathoms, mud, bottom temperature 51.8°F."

Type Locality: Off Cape Lobos, Gulf of California, in 58 fathoms, mud.

Range: Santa Maria Bay, Lower California, to Santa Inez Bay, Gulf of California, and south to the Gulf of Chiriqui, Panama.

Collecting Stations: Mexico: Arena Bank, Gulf of California (136-D-4, 6, 9, 14, 17, 23, 24), 35-55 fathoms, mud, sand, weed, *Arca* conglomerates; Santa Inez Bay, Gulf of California (146-D-1), 35 fathoms, mud, crushed shell; Gorda Banks, Gulf of California (150-D-23), 45 fathoms, sand, calcareous algae; Costa Rica: off Ballena Bay, Gulf of Nicoya (213-D-11, 17), 35 fathoms, mud; Panama: Gulf of Chiriqui (221-D-1, 5), 35-40 fathoms, sandy mud.

Description: Shell fusiform, thin, spire acute, whorls angulated; sculpture consisting of about 12 short, oblique, protractive axial ribs, about 12 on the last whorl on which 2 or 3 are much larger than the others; axials crossed by spiral threads of which 2 on the periphery are slightly larger than the others; canal long, narrow, slightly recurved; pale brown, interior pinkish.

A specimen from Arena Bank, Gulf of California, measures: height, 40.3 mm.; maximum diameter, 14 mm.

The shell of this species differs from that of *Fusiturricula fusinella* Dall in that the axial ribs are oblique rather than straight and in that on large specimens about every fourth rib is enlarged.

Distribution: A number of specimens of this species were dredged by the expedition in the region between Santa Inez Bay, Gulf of California, and the Gulf of Chiriqui, Panama.

Fusiturricula howelli

Hertlein & Strong, sp. nov.

Plate VIII, Fig. 8.

Shell slender, acute, bleached a dull white; nucleus defective; normal whorls 8, strongly shouldered; axial sculpture of 9 nearly vertical, strong ribs which undulate the sutures, feeble above the shoulder angle and extending over the base to the canal; spiral sculpture of raised cords, 3 above the shoulder angle and 4 much stronger below, riding over the ribs on the tops of which they are somewhat swollen, base and canal with about 30 closely spaced cords which have a tendency to alternate in strength; aperture with the outer lip not varicose but turned in by the last rib, notch triangular, close to the suture, inner lip with a thin wash of callus; canal open, long, straight and slender. The type measures: length, 31 mm.; length of aperture and canal, 16 mm.; maximum diameter, 11 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 214-D-1, 4, 14 miles S. X E. of Judas Point, Costa Rica, Lat. 9° 19′ 32″ to 9° 17′ 40″ N., Long. 84° 29′ 30″ to 84° 27′ 30″ W., dredged in 42-61 fathoms (76.5-112 meters), mud, shell, rocks.

This species bears some resemblance to the species described by Dall as *Turris* (*Surcula*) *fusinella*[13], but differs in that the axial ribs are continuous rather than represented by spirally elongated nodes arranged in axial lines.

There is doubt as to whether the species here described as new should be placed in the genus *Fusiturricula* in which the axial ribs are said to be similar to those described on *T. fusinella*. However, it appears best to leave it in *Fusiturricula* until more is known of the variation of the characters of the type species of the various genera of this family.

This species is named for Mr. John Thomas Howell, Curator of the Department of Botany, California Academy of Sciences.

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[12] *Glyphostoma sirena* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 53, pl. 17, fig. 3. "Range.—Station 2813, in the Galapagos Islands, in 40 fathoms, coral sand, surface temperature 81° F. U. S. Bureau of Fisheries."

[13] *Turris* (*Surcula*) *fusinella* Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 261, pl. 14, fig. 7. "U. S. S. 'Albatross' station 3391, in the Gulf of Panama, in 153 fathoms, mud, bottom temperature 55.8° F." Also off Cape Lobos, Gulf of California, west coast of Mexico, in 58 fathoms.

Genus **Crassispira** Swainson.

Crassispira turricula ballenaensis

Hertlein & Strong, subsp. nov.

Plate XI, Figs. 4, 11.

The shell of this subspecies differs from that of typical *Crassispira turricula* Sowerby in that the whorls are more rounded, the last whorl is shorter in proportion to the height and the axial ribbing is finer. The color is dark brown. Dimensions of holotype: length, 33.2 mm.; maximum diameter, 11 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 206-D-1, 3, Lat. 10° 37′ 03″ to 10° 36′ 22″ N., Long. 85° 41′ 12″ to 85° 41′ 08″ W., off Port Culebra, Costa Rica, in 14 fathoms (25.5 meters), sandy mud. 1 specimen was dredged at Station 213-D-11, 17, Lat. 9° 44′ 52″ N., Long. 84° 51′ 25″ W., to Lat. 9° 42′ 00″ N., Long. 84° 56′ 00″ W., off Ballena Bay, Gulf of Nicoya, Costa Rica, in 35 fathoms (63.7 meters), mud. 5 specimens were dredged at Station 183-D-3, Lat. 19° 14′ 30″ N., Long. 104° 51′ 30″ W., Tenacatita Bay, Mexico, in 40 fathoms (73 meters), sandy mud. 3 specimens were dredged in Acapulco Bay, Mexico, by the Templeton Crocker Expedition of the California Academy of Sciences in 1932.

Pleurotoma turricula Sowerby[14] was described in 1834. On the same page immediately following this description Sowerby also described *Pleurotoma corrugata*[15]. Reeve in 1843 illustrated *Pleurotoma turricula,* placed *P. corrugata* in the synonymy and stated that there was not the slightest difference between the specimens upon which Sowerby based the two specific names. Reeve also indicated that Sowerby's *P. corrugata* was distinct from a species from West Africa which also was described as *Pleurotoma corrugata* by Kiener. This African species was not described until 1839-1840 and therefore does not take priority over Sowerby's earlier use of the same combination of names. In a later portion of his monograph of *Pleurotoma* Reeve illustrated (his species 162) under the name of *Pleurotoma turricula* the species originally described from England by Montagu in 1803 as *Murex turricula.* In the errata to his monograph Reeve renamed the west American shell, Sowerby's *Pleurotoma turricula* (Reeve's species 49), *Pleurotoma sowerbyi. Murex turricula* Montagu was designated as the type of a genus *Propebela* Iredale, 1918, but Winckworth, 1932, placed the species in the genus *Lora* Gistel, 1848. Sowerby's *Pleurotoma turricula* has line priority over his *P. corrugata.* It appears then that *turricula* is the valid specific name for the west American shell of which we here describe a new subspecies as *Crassispira turricula ballenaensis.*

The species from Panama cited by C. B. Adams, 1852, under the name of *Pleurotoma corrugata* Sowerby was later described as a new species, *Crassispira adamsiana,* by Pilsbry & Lowe.[16]

Crassispira chacei

Hertlein & Strong, sp. nov.

Plate I, Fig. 12.

Shell stout, brownish; nucleus and first 3 or 4 postnuclear whorls lost, remaining whorls 8; anal fasciole strongly impressed, sculptured with fine curved lines of growth and microscopic spiral striations, close to the suture but is separated from it by a narrow raised band on which there are 1 or 2 fine spiral threads; axial sculpture of (on the last whorl 14) slightly protractive ribs, which are highest at the margin of the anal fasciole, flattening out toward the suture and fading out on the lower part of the base; spiral sculpture of subequal, raised threads which ride over the axial ribs, of these there are 7 on the penultimate whorl between the lower edge of the anal fasciole and the following suture and about 20 on the base and canal; aperture narrow, outer lip thin at the edge, with an indistinct stromboid notch, the last axial rib varicose and some distance back; anal sinus small, deep, rounded, with a raised pile of callus on the body; inner lip callous, with a raised edge along the canal; canal very short, slightly recurved. The type measures: length, 29.5 mm.; maximum diameter, 10.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 150-D-23, Lat. 23° 01′ 00″ N., Long. 109° 27′ 30″ W., Gorda Banks, Gulf of California, dredged in 45 fathoms (82 meters), sand, calcareous algae. 1 specimen was taken nearby at Station 150-D-9, 50-60 fathoms (91-109 meters), muddy sand. 1 specimen was dredged at Station 142-D-3, Lat. 27° 04′ 00″ N., Long. 111° 54′ 00″ W., Santa Inez Bay, Lower California, Gulf of California, in 40 fathoms (73 meters), sand, weed.

This species resembles *Crassispira turricula* Sowerby (*Crassispira sowerbyi* Reeve[17]) in many ways, but the canal is much shorter and the axial ribs do not cross the anal fasciole to form nodules on the subsutural band as on Sowerby's species. All the specimens secured are more or less

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14 *Pleurotoma turricula* Sowerby, *Proc. Zool. Soc. London* for 1833, p. 137 (issued April 16, 1834). "Hab. ad Sanctam Elenam Columbiae Occidentalis." "From sandy mud at a depth of six fathoms."—Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, 1843, sp. 49, pl. 6, fig. 49. In errata it is stated "Species 49. For *P. turricula*, Sowerby—read *P. sowerbyi*, Reeve; and for *P. turricula*, refer to species 162." —Tryon, Man. Conch., Vol. 6, 1884, p. 180, pl. 10, fig. 67 (as *Drillia sowerbyi*). Not *Murex turricula* Montagu, Test. Brit., Pt. 1, 1803, p. 262, Suppl. Tab. 9, fig. 1.

15 *Pleurotoma corrugata* Sowerby, *Proc. Zool. Soc. London* for 1833, p. 137 (issued April 16, 1834). "Hab. ad Sinum Montijae et ad Portam Portreram." "Found in muddy sand at ten fathoms' depth." Not *Pleurotoma corrugata* Kiener, Spéc. Gén. et Icon. Coq. Viv., Fam. Canalifères, Pt. 1, *Pleurotoma*, 1839-1840, p. 26, pl. 9, fig. 2. "Habite les côtes de Gorée et de Guinée."

16 *Crassispira adamsiana* Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 48, pl. 2, fig. 11. Type from "Reef off 'French Plaza', Panama City." Also collected at San Juan del Sur, Nicaragua.

17 See Reeve, L., Conch. Icon., Vol. 1, *Pleurotoma*, 1843, pl. 6, fig. 49.

bleached. Living shells are probably uniformly dark brown or blackish.

This species is named for Emery Chace of Lomita, California, an indefatigable collector of west American shells.

Crassispira brujae

Hertlein & Strong, sp. nov.

Plate I, Fig. 18.

Shell slender, whitish under a persistent black periostracum; nuclear whorls 2, very small, smooth; postnuclear whorls 12; axial sculpture of (on the penultimate whorl 12) narrow ribs, strongest just below the anal fasciole, extending to the following suture, fading out on the base, absent on the narrow anal fasciole but appearing as faint nodes on the low, narrow, subsutural cord; entire surface with microscopic spiral striations; base and canal with about a dozen fine spiral threads, those on the canal slightly the stronger and faintly nodulous; aperture narrow, outer lip thin at the edge, the last 2 axial ribs enlarged, forming a slight hump; anal sulcus deep, rounded, with a projecting subsutural callosity; inner lip callous, with a raised edge; canal short, slightly recurved. The type measures: length, 29 mm.; maximum diameter, 9.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 136-D-13, Lat. 23° 29′ 00″ N., Long. 109° 24′ 00″ W., Arena Bank, Gulf of California, in 45 fathoms (82 meters), mud, *Arca* conglomerates.

The sculpture of the unique type is somewhat similar to that of *Crassispira erigone* Dall[18] described from Panama Bay, but is much finer. The shell also is much more slender than Dall's species. It also is more slender and the nodes on the subsutural cord are much finer than on *C. erebus* Pilsbry & Lowe.[19]

The specific name of this species is derived from that of the ship *Bruja* on which Lieut. R. W. H. Hardy explored the upper portion of the Gulf of California, 1825-1828.

Crassispira ericana

Hertlein & Strong, sp. nov.

Plate I, Fig. 11.

Shell small, rather thick, with a persistent black periostracum; nuclear and first 2 or 3 postnuclear whorls lost, remaining whorls 8, sutures appressed, undulated by the axial ribs; axial sculpture of (on the last whorl 12) ribs, broadest near the anal fasciole, extending to the following suture and fading out on the base, absent on the anal fasciole and subsutural band; subsutural band moderately wide, axially striated, bounded at the lower edge by a strong cord; anal fasciole broad, sculptured by 4 spiral threads crossed by strong lines of growth; other spiral sculpture of fine raised threads in the interspaces between the axial ribs similar to those on the anal fasciole, 6 appearing on the penultimate whorl and about 24 on the base and canal; aperture narrow, purplish; outer lip slightly thickened, not varicose, anal sulcus small, very deep, the outer edge strongly constricted by a strong subsutural callosity; inner lip callous, the edge scarcely raised; canal short, slightly recurved. The type measures: length, 11.5 mm.; maximum diameter, 4.3 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., Santa Inez Bay, Lower California, Gulf of California, in 4-13 fathoms (7.5-24 meters), sand.

In many ways this shell fits the description of the unfigured *?Drillia hanleyi* Carpenter,[20] but the axial ribs would seem to be fewer in number and more nearly vertical. The presence of a strong subsutural cord on the present shell serves to separate it from *C. tepocana* Dall.[21]

This species is named in honor of Eric Knight Jordan in recognition of his contributions to the knowledge of West American marine mollusks.

Crassispira xanti

Hertlein & Strong, sp. nov.

Plate I, Fig. 3.

Shell small, stout, with a pointed spire and a persistent black periostracum; nuclear whorls 2, smooth, whitish; postnuclear whorls 9, with the subsutural band and anal fasciole occupying more than half the space between the sutures; axial sculpture of (on the last whorl 12) strong ribs, extending from the anal fasciole to the following suture and over the base to the siphonal fasciole, absent on the anal fasciole and subsutural band; subsutural band broad, bordered at the lower edge by a smooth keel, between which and the suture there are 4 subequal spiral threads crossed by strong lines of growth; anal fasciole with 3 similar but more distinct spiral threads, below which there are 3 sharply incised spiral lines in the interspaces between the axial ribs; periphery with a broad space on which the spiral sculpture is indistinct, followed by an incised spiral line and about 13 subequal spiral threads on the base; aperture purplish at the edge, white within, narrow; outer lip with a shallow but distinct stromboid notch, somewhat thickened by the last rib which is slightly swollen; anal sulcus shallow, rounded (probably not mature) with a small subsutural

[18] *Crassispira erigone* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 21, pl. 7, fig. 8. "Range.—Station 2798, in Panama Bay, in 18 fathoms; U. S. Bureau of Fisheries."

[19] *Crassispira erebus* Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 49, pl. 2, fig. 10. "Corinto, Nicaragua, in about 20 fathoms (Lowe)."

[20] *?Drillia hanleyi* Carpenter, Cat. Mazatlan Shells, November, 1856, p. 398. "Hab.—Mazatlan; 1 fresh sp., L'pool Col."

[21] *Crassispira tepocana* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 25, pl. 6, fig. 5. "Range.—Station 3018, off Cape Tepoca, Lower California, in 36 fathoms, sand, bottom temperature 63.8° F; U. S. Bureau of Fisheries."

callosity; inner lip callous, purplish, with the edge little raised; siphonal fasciole distinct, sculptured with fine lines of growth and followed by 6 spiral cords; canal short, slightly recurved. The type measures: length, 15.5 mm.; maximum diameter, 5.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 135, dredged in San Lucas Bay at the southern end of Lower California, Mexico. 1 specimen was dredged at Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., Port Guatulco, Mexico, in 7 fathoms (12.6 meters), gr. sand, crushed shell. 1 specimen was dredged at Station 200-D-16, Lat. 12° 27′ 41″ N., Long. 87° 12′ 08″ W., near Corinto, Nicaragua, in 4-7 fathoms (7-13 meters), mangrove leaves. 1 small specimen was taken at Port Parker, Costa Rica, and 2 specimens at Piedra Blanca, Costa Rica.

The shell of the present species resembles the preceding species in general appearance but is broader and differs in the ornamentation of the subsutural area. This species appears in some instances to have been recorded as *Crassispira nigerrima* Sowerby.[22] It differs from that species in the narrower axial ribs and very broad subsutural area which bears a much stronger carina which occurs much farther anterior to the suture. For comparative study, we have used 2 specimens of *C. nigerrima* in the collections of the California Academy of Sciences which were collected at Santa Elena Bay, Ecuador, by Woodbridge Williams, which agree exceedingly well with Reeve's illustration of that species.

This species is named for John Xantus who collected many specimens of marine mollusks at Cape San Lucas, Lower California.

Crassispira tangolaensis Hertlein & Strong, sp. nov.

Plate I, Fig. 13.

Shell small, biconic, uniformly dark, the extreme tip broken, remaining whorls 8, strongly sculptured; axial sculpture of 12 strong, somewhat retractive ribs, fading out on the base, very faint over the narrow, depressed fasciole but rising to rounded tubercles at the suture; spiral sculpture of very fine, closely spaced threads over the entire surface, on the base every third or fourth thread the strongest; aperture narrow, outer lip thickened, with a small, rounded anal sulcus near the suture; inner lip simple, canal very short, hardly differentiated. The type measures: length, 14 mm.; maximum diameter, 5.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 196-D-6, 7, Lat. 15° 45′ 34″ N., Long. 96° 06′ 02″ to 96° 06′ 03″ W., Tangola-Tangola Bay, Mexico, dredged in 6-7 fathoms (11-12.8 meters), sand, crushed shell bottom.

The axial ribbing on the shell of this species bears some similarity to that of *Pleurotoma rustica* Sowerby[23] but it differs in that the whorls of that species are said to be keeled near the suture whereas on the present shell a row of tubercles is present near the suture.

Genus *Elaeocyma* Dall.

Elaeocyma craneana Hertlein & Strong, sp. nov.

Plate I, Fig. 2.

Shell slender, acute, dull white; nucleus of 2 bright, shining whorls, the first smooth, inflated, the second with a peripheral keel; normal whorls 10; axial sculpture of 12 strong ribs, extending from the anal fasciole to the canal but absent for a short distance back of the outer lip, and strong lines of growth prominent and curved on the fasciole; spiral sculpture indistinct on the spire, gradually increasing in strength toward the periphery, base and canal with 12 narrow spiral cords; aperture rather wide, outer lip smooth, sharp, inner lip curved, with a raised callus, and ending in a callus pile separating the deep, rounded sinus from the body of the shell; canal open, distinct, set off by a raised thread marking the siphonal fasciole. The type measures: length, 21 mm.; maximum diameter, 8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Bahia Honda, Panama.

This species is of much the same form as *Elaeocyma pallida* Sowerby[24] from the same general locality but is larger with fewer and stronger axial ribs and only indistinct spiral sculpture. The species described as *Pleurotoma* (*Drillia*) *cretata* by E. A. Smith[25] appears to be another member of this group.

This species is named for Miss Jocelyn Crane, Technical Associate, Department of Tropical Research, New York Zoological Society, who accompanied the Eastern Pacific *Zaca* expedition, 1937-1938, during the course of which the type of the present species was collected.

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22 *Pleurotoma nigerrima* Sowerby, *Proc. Zool. Soc. London* for 1833, p. 137 (issued April 16, 1834). "Hab. ad Panamam." "Dredged in sandy mud in six and ten fathoms."—Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, 1843, sp. 102, pl. 12, fig. 102. "Hab. Panama and Bay of Caraccas (dredged from sandy mud at the depth of ten fathoms); Cuming."

The species named *Pleurotoma cornuta* Sowerby (*Proc. Zool. Soc. London* for 1833, p. 136 (issued April 16, 1834.) "Hab. ad Sinum Caraccas Columbiae Occidentalis." "Found in sandy mud at a depth of ten fathoms.") has not been illustrated but has generally been considered to be identical with *P. nigerrima*. It has page priority over the latter but the species is so well known under the name of *P. nigerrima* that we favor acceptance of this name.

23 *Pleurotoma rustica* Sowerby, *Proc. Zool. Soc. London* for 1833, p. 138 (issued April 16, 1834). "Hab. sub lapidibus ad Xipixapi Columbiae Occidentalis."—Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, 1843, sp. 91, pl. 11, fig. 91.

24 *Pleurotoma pallida* Sowerby, *Proc. Zool. Soc. London* for 1833, p. 137 (issued April 16, 1834). "Hab. ad Portam Portreram Americae Centralis." "Found in thirteen fathoms, on a sandy muddy floor."—Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, 1843, sp. 134, pl. 16, fig. 134.—Tryon, Man. Conch., Vol. 6, 1884, p. 196, pl. 14, fig. 8 (as *Drillia pallida*).

25 *Pleurotoma* (*Drillia*) *cretata* E. A. Smith, *Ann. & Mag. Nat. Hist.*, Ser. 6, Vol. 2, No. 10, October, 1888, p. 305. "Hab. Panama (A. H. Cooke)."

Elaeocyma salvadorica
Hertlein & Strong, sp. nov.
Plate XI, Fig. 5.

Shell large for the genus, acute, white; nuclear whorls defective, remaining whorls 11; axial sculpture of 16 protractive ribs which extend from suture to suture and over the base to the canal, strongly curved where they cross the depressed anal fasciole and indistinct on the last third of the body whorl between a light stained hump and the edge of the outer lip; spiral sculpture of closely spaced, flattened cords separated by sharp, incised lines which cut across the ribs, rendering them slightly nodulous, 3 appearing on the fasciole and 6 between it and the periphery, base and canal with 12 similar cords; aperture short, outer lip thin, sharp, inner lip with a raised callus ending in a callus pile separating the very narrow, deep anal sinus from the body of the shell; canal short, deep, slightly recurved with a shelly siphonal sinus. The type measures: length, 29 mm.; maximum diameter, 11 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 198-D-1, off La Libertad, El Salvador, Lat. 13° 27′ 20″ N., Long. 89° 19′ 20″ W., dredged in 13 fathoms (24 meters), mud.

This species is very similar in many ways to *Elaeocyma pallida* Sowerby[26] but is larger with fewer and less well developed ribs. It is larger and is sculptured with more numerous axial ribs than *E. craneana.*

Genus ***Kylix*** Dall.

Kylix turveri Hertlein & Strong, sp. nov.
Plate I, Fig. 1.

Shell small, with a pointed spire, pinkish-white, shining; nuclear whorls 2, swollen, with a peripheral keel; postnuclear whorls 9; axial sculpture of (on the penultimate whorl 20) strong ribs, with narrower interspaces, lower and curved over the constricted anal fasciole, rising to points at the suture, extending over the base to the siphonal fasciole, obsolete on the last quarter turn; spire with 3 or 4 sharply incised spiral lines between the anal fasciole and the following suture which cut the axial ribs into somewhat rounded segments; base similarly sculptured with 10 incised lines between the periphery and the siphonal fasciole and 4 or 5 cords on the canal; aperture narrow, smooth within, with a very slight varicose hump and a distinct stromboid notch; anal sulcus deep, rounded, with a projecting subsutural callosity; inner lip callous, with the edge reflected; canal short, somewhat recurved. The type measures: length, 19.3 mm.; maximum diameter, 7.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 142-D-2, Santa Inez Bay, east coast of Lower California, Lat. 27° 04′ 00″ N., Long. 111° 55′ 00″ W., dredged in 30-35 fathoms (54-64 meters), muddy sand, crushed shell.

The unique type of this new species appears to belong in the group with *?Clathrodrillia (Kylix) alcmene* Dall[27] and *?Clathrodrillia (Kylix) alcyone* Dall[28], having similar sculpture and color. However, in the present species the anal sulcus is deep, with a projecting callosity, and the number of incised spiral lines is different from those on the two species described by Dall. Dall stated with regard to *alcmene* that the aperture is "probably not quite mature" and of *alcyone* that "It has every appearance of being adult." In the figure of *alcyone* the outer lip does not seem to be fully formed.

This species is named for Mr. Harry R. Turver of South Gate, California.

Kylix zacae Hertlein & Strong, sp. nov.
Plate I, Fig. 5.

Shell small, with a pointed spire, brownish-white, shining; nuclear whorls lost, remaining whorls 8; axial sculpture of (on the penultimate whorl 14) broad ribs, curved over the narrow, rather indistinct anal fasciole, somewhat nodulous at the suture, extending over the base to the siphonal fasciole; spire with from 3 to 5 sharply incised spiral lines between the anal fasciole and the following suture which cut the axial ribs into spirally elongated segments, base with 10 similar incised spiral lines between the periphery and the siphonal fasciole, followed by 5 cords on the canal; aperture narrow, smooth within; outer lip thin, externally with fine axial striae for some distance back from the edge; the stromboid notch shallow, indistinct; anal sulcus deep, rounded, with a projecting subsutural callosity; inner lip callous, the edge slightly raised; canal short, somewhat recurved. The type measures: length, 14.5 mm.; maximum diameter, 5.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.) from Station 145-D-1, 3, off San Domingo Point, Santa Inez Bay, east coast of Lower California, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., dredged in 4-13 fathoms (7.5-24 meters), sand. A second specimen, dredged at the same locality, has 2 swollen nuclear whorls, the second with a strong peripheral keel.

The shell of this species is quite similar to that of the preceding species, *K. turveri,* but is smaller and with fewer and broader axial ribs.

Genus ***Cymatosyrinx*** Dall.

Cymatosyrinx arenensis
Hertlein & Strong, sp. nov.
Plate I, Fig. 17.

Shell slender, strong, polished, white, light brown on the fasciole and on the lower part

[26] For references to this species see footnote No. 24, p. 75.

[27] *?Clathrodrillia (Kylix) alcmene* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 19, [not figured]. "Range.—Dredged at Agua Verde Bay, Gulf of California, by Dr. Paul Bartsch."

[28] *?Clathrodrillia (Kylix) alcyone* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 20, pl. 2, fig. 3. "Range.—Station 3016, on the west coast of Mexico off Cape Lobos, in 76 fathoms, mud, bottom temperature 59° F. U. S. Bureau of Fisheries."

of the base; nuclear whorls decollated; postnuclear whorls 13, with a broad anal fasciole and appressed suture; axial sculpture of strong, rounded ribs, 12 on the body whorl, reaching from suture to suture and over the base to the siphonal fasciole, sharply pinched in on the middle of the anal fasciole; spiral sculpture of fine threads, 5 or 6 between the anal fasciole and the following suture, and about 10 on the base; aperture short, internally white with a brown band; outer lip thin at the edge, thickened just back of it by the last axial rib, notch deep, rounded, close to the suture, with a raised edge and a small callus pile on the body of the shell; columella with a strong, white callus; siphonal notch distinct with a broad, smooth fasciole; canal short, slightly recurved. The type measures: length, 45 mm.; maximum diameter, 14.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 136-D-22, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., Arena Bank, Gulf of California, in 45 fathoms (82 meters), mud. A second specimen was dredged at the same locality. 3 specimens were dredged in this general locality at Station 136-D-4, Lat. 23° 32′ 00″ N., Long. 109° 27′ 00″ W., in 55 fathoms (100 meters), mud; 1 specimen at Station 136-D-14, Lat. 23° 29′ 30″ N,. Long. 109° 25′ 00″ W., in 45 fathoms (82 meters), mud; 1 specimen at Station 136-D-21, Lat. 23° 29′ 00″ N., Long. 109° 25′ 00″ W., in 45 fathoms (82 meters), mud; 1 specimen at Station 136-D-32, Lat. 23° 24′ 30″ N., Long. 109° 24′ 00″ W., in 42 fathoms (76 meters), sand; 3 specimens were dredged at Station 150-D-23, Lat. 23° 01′ 00″ N., Long. 109° 27′ 30″ W., Gorda Banks, in 45 fathoms (82 meters), sand, calcareous algae.

This species belongs in a group of species including *Cymatosyrinx empyrosia* Dall.[29] It differs from Dall's species and others in the group in the much larger size and the better development of axial ribs.

Cymatosyrinx allyniana

Hertlein & Strong, sp. nov.

Plate I, Fig. 7

Shell small, acute, uniformly grayish-white; the extreme tip broken, remaining whorls 9; axial sculpture of (on the last whorl 14) strong ribs, straight over the body of the whorls, continuous over the base to the canal, on the deeply impressed anal fasciole they become very fine and strongly curved but rise to points at the appressed suture; other axial sculpture of curved lines of growth on the fasciole; spiral sculpture of about 8 fine, close, raised threads on the whorls below the fasciole on the spire and about 12 additional similar threads on the base, followed by 6 slightly larger cords on the canal; aperture short, with a deep, rounded, anal fasciole and a strong subsutural callosity; outer lip thin at the edge, smooth within, thickened by the first rib which is slightly varicose; inner lip with a pure white callus which is extended along the canal with a raised, somewhat reflected edge; canal short, deep, slightly recurved. The type measures: length, 20.7 mm.; maximum diameter, 8.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 136-D-4, Lat. 23° 32′ 00″ N., Long. 109° 27′ 00″ W., Arena Bank, Gulf of California, in 55 fathoms (100 meters), mud. Additional specimens were dredged in the same general locality as follows: 1 specimen from Station 136-D-18, Lat. 23° 30′ 00″ N., Long. 109° 25′ 00″ W., in 40 fathoms (73 meters), mud; 1 specimen from Station 136-D-24, Lat. 23° 29′ 00″ N., Long. 109° 23′ 30″ W., in 50 fathoms (91 meters), mud. *Arca* conglomerates; 1 specimen from Station 136, the exact haul number unknown.

In many features this species resembles ?*Elaeocyma aerope* Dall[30] and *E. acapulcana* Lowe[31] but differs markedly from both of them in the more slender shell, more deeply impressed anal fasciole, more numerous raised ribs and in the strongly raised spiral threads.

This species is named for Mr. Allyn G. Smith, Research Associate, Department of Paleontology, California Academy of Sciences.

Cymatosyrinx strohbeeni

Hertlein & Strong, sp. nov.

Plate I, Fig. 14.

Shell small, slender, shining, flesh-colored, with a row of light brown patches between the axial ribs on the anal fasciole and a fainter row of similar spots near the middle of the whorls; nuclear whorls 2½, smooth, pale brown, translucent; postnuclear whorls 9; axial sculpture of (on the last whorl 12) protractive, curved ribs, continuous from suture to suture and over the base to the canal, but constricted and cut by a fine incised spiral line to form the anal fasciole, leaving a row of rounded nodes against the appressed suture; spiral sculpture of 4 incised spiral lines in the interspaces between the axial ribs on the spire, base with 6 similar incised spiral lines of which the lower 3 cut across the continuation of the axial ribs and are followed by 3 closely set cords on the canal; aperture narrow, anal sulcus deep, narrow, with a broad subsutural callus; outer lip thin at the edge, thickened by the first rib; pillar with a raised white callus; canal very short, deep, slightly recurved. The type measures: length, 11.5 mm.; maximum diameter, 3.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo.

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29 *Drillia empyrosia* Dall, *Nautilus*, Vol. 12, No. 11, March, 1899, p. 127. "Found in deep water off San Pedro, Cala., by Mr. and Mrs. T. S. Oldroyd."—Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, 1919, p. 12, pl. 4, fig. 1 (as "*Elaeocyma empyrosia*").

30 ?*Elaeocyma aerope* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 13, pl. 1, fig. 3. "Range.—Agua Verde Bay, Lower California, Dr. Paul Bartsch."

31 *Elaeocyma acapulcana* Lowe, *Trans. San Diego Soc. Nat. Hist.*, Vol. 8, No. 6, March 21, 1935, p. 23, pl. 4, fig. 1. "Acapulco, dredged 20 fathoms (1930)."

Type Coll.), dredged off Cape San Lucas, Lower California. Seven additional specimens were dredged at the same locality.

This species belongs in the group of species combined by Grant & Gale[32] under the name of *Clavus* (*Cymatosyrinx*) *hemphillii* Stearns.[33] Of this group it is nearest to *Elaeocyma arbela* Dall[34] from Scammon Lagoon, differing in the more slender form and lighter color as well as in the details of the sculpture.

This species is named for Mr. John Strohbeen of Santa Cruz, California.

Cymatosyrinx asaedai

Hertlein & Strong, sp. nov.

Plate I, Fig. 4.

Shell of medium size, with a sharp pointed spire, uniformly whitish (probably bleached); nuclear whorls partly broken, one smooth whorl remaining; postnuclear whorls 11, sutures closely appressed; axial sculpture of (on the penultimate whorl 13) short, slightly protractive ribs, strongest just below the anal fasciole, fading out on the base, obsolete on the last quarter turn; entire surface with microscopic incised spiral lines and lines of growth; anal fasciole broad, without a subsutural band or rib, showing the continuations of the axial ribs very faintly; aperture narrow, with a deep, rounded anal sinus and a strong, rounded subsutural callosity; outer lip thin at the edge, thickened a short distance back by a slight swelling, smooth within; inner lip eroded, canal short, defective. The type measures: length, 27 mm.; maximum diameter, 9.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 136-D-2, Lat. 23° 30′ 30″ N., Long. 109° 26′ 00″ W., Arena Bank, Gulf of California, in 45 fathoms (82 meters), mud, *Arca* conglomerates.

The unique type is about the size and shape of *C. rosea* Sowerby[35] but the latter has a narrower fasciole, fewer and more rounded ribs and lacks the microscopic sculpture.

The shell of this species bears a general resemblance to that of the species described as *Clavatula quisqualis* Hinds[36] but differs in the greater size, presence of microscopic spiral lines and in other details.

This species is named for Mr. Toshio Asaeda, photographer and preparateur, who accompanied the expedition during which the type specimen of the present species was collected.

Genus *Kurtzina* Bartsch.

Kurtzina cyrene Dall.

Plate VIII, Fig. 9.

Mangilia (*Kurtziella*) *cyrene* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 62, Pl. 21, fig. 5. "Range.—Station 2823, off La Paz, Lower California, in about 26 fathoms, broken shell. U. S. Bureau of Fisheries."

Type Locality: Off La Paz, Lower California, in about 26 fathoms, broken shell.

Range: Santa Inez Bay, Gulf of California, to San Juan del Sur, Nicaragua.

Collecting Station: Mexico: Santa Inez Bay, Gulf of California (145-D-1, 3), 4-13 fathoms, sand.

Description: Shell small, whorls obtusely angulated; axial sculpture consists of about 8-10 ribs (on the last whorl); spiral sculpture consists of about 12 threads (on the last whorl), the peripheral thread the strongest; incremental lines of growth are closely spaced giving a characteristic frosted appearance to the surface. Length, 8.5 mm.; diameter, 3.4 mm.

Distribution: A few specimens of this species were dredged in Santa Inez Bay, Gulf of California, in 4-13 fathoms. This is an extension north of the known range of this species.

Genus *Crockerella*

Hertlein & Strong, gen. nov.

Shell small; nucleus smooth; outer lip varicose, smooth within; canal short but distinct, the anal sinus rounded, near the suture, and with little or no anal fasciole.

Type: *Clathurella crystallina* Gabb, *Proc. Calif. Acad. Nat. Sci.*, Vol. 3, January, 1865, p. 184. "Hab. Catalina Island, 40 fms. Dr. Cooper."—Dall, *U. S. Nat. Mus., Bull.* 112, 1921, p. 79, pl. 6, fig. 4 (as *Philbertia crystallina*). "Off Catalina Island, in 50 fathoms."

The species assigned to this genus differ from those generally assigned to *Philbertia* Monterosato and *Cytharella* Monterosato in that the anal fasciole is indistinct or lacking.

Crockerella pederseni

Hertlein & Strong, sp. nov.

Plate I, Fig. 15.

Shell very small, fusiform, white, with sharply cut sculpture giving it a frosted appearance; nuclear whorls 2, the first very small, smooth, the second much larger, an-

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[32] Grant, IV, U. S., & Gale, H. R., *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 577-578.

[33] *Pleurotoma* (*Drillia*) *hemphillii* Stearns, Conch. Memor., No. 7, August 28, 1871, (second page). "Habitat—Los Todos Santos Bay, Lower California."—Stearns, *Proc. Calif. Acad. Sci.*, Vol. 5, May, 1873, p. 80, pl. 1, fig. 3. Original locality cited.

[34] *Elaeocyma arbela* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2288, August 8, 1919, p. 10, pl. 4, fig. 3. "Range.—Scammon Lagoon, Lower California, collected by Henry Hemphill."

[35] *Pleurotoma rosea* Sowerby, *Proc. Zool. Soc. London* for 1833, p. 134 (issued April 16, 1834). "Hab. ad Salango et ad Montem Christi." "Found in sandy mud in from twelve to sixteen fathoms."—Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, 1843, sp. 43, pl. 6, fig. 43.—Tryon, Man. Conch., Vol. 6, 1884, p. 190, pl. 10, fig. 62 (as *Drillia rosea*).

[36] *Clavatula quisqualis* Hinds, Zool. Voy. *Sulphur*, Moll., Pt. 1, July, 1844, p. 19, pl. 6, fig. 5. "Inhab. Gulf of Papagayo, Central America. From eight to fourteen fathoms, mud."—Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, 1845, sp. 230, pl. 26, fig. 230.

Brazier, 1877, cited this species as occurring at Darnley Island, Torres Straits. Hedley (1913), referring to this record stated, "But, in the British Museum, two, perhaps types but not so marked, are labelled, 'W. coast of Central America, Sir E. Belcher Coll.' These two habitats are incompatible." *Drillia lucida* Nevill, 1875, was considered to be an oriental representative of *C. quisqualis*.

gulated in the middle, sculptured with a fine spiral cord on the angle and numerous fine axial riblets; postnuclear whorls 6; sutures distinctly undulated by the axial ribs, anal fasciole only feebly indicated; axial sculpture of 10 strong ribs, continuous up the spire and over the base to the canal; spiral sculpture of a strong cord on the angle of the whorls with 7 or 8 smaller threads between it and the preceding suture, below the angle there are 3 or 4 fine threads and then a cord only a little less strong than the one at the angle, with 3 finer threads between it and the following suture, on the last whorl below the angle there are 5 cords with 3 or 4 finer threads between each of them and then 10 more equal cords extending to the end of the canal, all spiral cords and threads riding over the axial ribs without nodulation; aperture narrow, outer lip thickened by the varicose swelling of the last rib, smooth within except for a slight swelling at the lower edge of the anal sulcus; anal sulcus shallow, rounded, close to the suture; inner lip not callous; canal hardly differentiated. The type measures: length, 4.8 mm., length of aperture and canal, 2.0 mm.; maximum diameter, 1.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., Santa Inez Bay, Gulf of California, in 4-13 fathoms (7.5-24 meters), sand.

The species described by Carpenter as *"Mangelia" subdiaphana*[37] from Cape San Lucas, Lower California, the type specimen of which was figured by Dall,[38] possesses a similar but less angulated shell. The description indicates a number of differences in the sculpture and in the color in comparison to those of the present species.

This species is named for Captain Alfred Pedersen of the yacht *Zaca*.

Crockerella hilli Hertlein & Strong, sp. nov.

Plate I, Fig. 16.

Shell very small, fusiform, white, with indications of a brown band in the suture, canal brown; nuclear whorls 2, the first minute, smooth, the second much larger, angulated in the middle, sculptured with fine axial riblets; postnuclear whorls 5, the upper whorls strongly angulated in the middle, the last less so, sutures appressed, undulated by the axial sculpture; axial sculpture of (on the last whorl 7) strong ribs with much wider interspaces, extending from suture to suture and over the base to the canal; spiral sculpture of a low, flattened cord on the angle of the whorl which rides over the axial ribs, and 2 similar cords between it and the following suture; base with 4 similar cords, followed by 7 rounded cords on the canal; aperture narrow, outer lip varicose, reflected, the face with microscopic axial and spiral threads; anal sulcus large, rather deep, close to the suture; inner lip without callus; canal very short. The type measures: length, 3.8 mm.; maximum diameter, 1.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters), sand. 9 additional specimens were dredged at the same locality.

This species is quite similar to the preceding one, *Crockerella pederseni*, differing principally in the more sharply angulated whorls and in the absence of the fine, secondary sculpture.

This species is named for Dr. Howard Hill, Curator of Mollusks in the Los Angeles County Museum, Los Angeles, California.

Genus **Cytharella** Monterosato.

Cytharella burchi Hertlein & Strong, sp. nov.

Plate I, Fig. 6.

Shell small, fusiform, uniformly light brown; nuclear whorls 3, translucent, dark brown, the first 2 smooth, the last with close-set, axial riblets; postnuclear whorls 7; axial sculpture of low, rounded ribs, continuous from the narrow, slightly depressed anal fasciole to the following suture and over the base to the canal, 16 appearing on the penultimate whorl; spiral sculpture of fine, subequal cords, 7 appearing on the anal fasciole, followed by 8 on the spire and about 50 on the last whorl, with occasional finer threads in the interspaces, these cords ride evenly over the axial ribs and are cut in turn by fine lines of growth, giving a finely cancellated surface to the entire shell; aperture narrow, about half as long as the shell; outer lip thickened by a strong varix, smooth within; anal sulcus deep, rounded, close to the suture; inner lip not callous, canal hardly differentiated. The type measures: length, 16.5 mm.; length of aperture and canal, 10.1 mm., maximum diameter, 6.3 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 136-D-22, Arena Bank, Gulf of California, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., dredged in 45 fathoms (82 meters), mud.

The unique type of this new species is quite similar in shape to *Cytharella carissima* Pilsbry & Lowe[39] but is much larger, lacks the spots of color and has somewhat coarser spiral sculpture.

This species is named for Mr. John Q. Burch of Los Angeles, California.

Superfamily Rhachiglossa.

FAMILY FASCIOLARIIDAE.

Genus **Latirus** Montfort.

Latirus hemphilli Hertlein & Strong, sp. nov.

Plate II, Fig. 4.

Shell fusiform, moderately slender, spire

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37 *Mangelia subdiaphana* Carpenter, *Ann. & Mag. Nat. Hist.*, Ser. 3, Vol. 14, July, 1864, p. 45. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, p. 218. "Cape St. Lucas."

38 *Cytharella subdiaphana* Carpenter, Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, 1919, p. 75, pl. 24, fig. 4.

39 *Cytharella carissima* Pilsbry & Lowe, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 84, May 21, 1932, p. 58, pl. 4, figs. 1, 1a. "Manzanillo, dredged in about 20 fathoms (H. N. Lowe.)"

high, thick, whorls broadly rounded; sculpture consists of rather broad axial folds or ridges which are crossed by spiral threads varying in size, on the earlier whorls 2 or 3 threads stand out stronger than the others; aperture elongately ovate, anterior canal moderately long, a siphonal fasciole present, the columella bears 3 oblique plaits; color yellowish covered with a dark brown periostracum, interior white. Dimensions of the holotype: length, 68.5 mm.; maximum diameter, 23.8 mm.; height of spire, 39 mm.

Holotype and paratypes (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Port Parker, Costa Rica. 10 specimens, rather small, were dredged near the same locality (203-D-1-3), in 12-15 fathoms (22-27 meters). 2 specimens were dredged at Port Culebra, Costa Rica (206-D-1-3), in 14 fathoms (25.5 meters), sandy mud.

Range: Off Santa Margarita Island, Magdalena Bay, Lower California, to Taboga Island, Panama.

The shell of this species is somewhat variable. Some specimens, especially young forms, are shorter and broader than adult shells, some of which are quite elongate. The axial ridges are often weaker on the body whorl of adult shells.

The shell of this new species differs from that of the following species, *Latirus mediamericanus*, in that the whorls as well as the axial ridges are more rounded, and the spiral threads are very much stronger especially on the body whorl.

This species probably has been cited from tropical west American waters under the name of *Latirus spadiceus* Reeve. C. B. Adams, 1852, cited Reeve's species from Taboga Island, Panama; Melvill, 1891, cited it from Acapulco and Panama but also from "Fernando Noronha (Ridley)", off Brazil, and Pilsbry & Lowe, 1932, cited it from Acapulco and San Juan del Sur. *Turbinella spadicea* Reeve[40] was originally described without information as to the locality from which it came. Some of our specimens bear a resemblance to Reeve's illustration of that species but none of them are as broad in proportion to the height, the whorls are less strongly rounded and the canal is longer. The whorls of Reeve's species appear to be more tumid than those of our shells but less so than *Latirus tumens* Carpenter[41] which approaches the Indo-Pacific *L. nodatus* Martyn. Reeve, Melvill, and Hidalgo [42] cited the latter species from Panama. Pease[43] long ago stated that it does not occur in west American waters. We have not seen any specimens from Panama or other west American localities which we could refer to *L. tumens* on the basis of Melvill's figure.

The present species, *Latirus hemphilli*, bears considerable resemblance to the species described as *Turbinella acuminata* Wood,[44] a Philippine species, but is more slender in outline, the concentric ribbing appears to be less evenly arranged and it possesses a well developed siphonal fasciole. Kiener later proposed the same name for the Philippine shell and referred to Wood's original figure. The illustrations of Wood's species given by Wood, Kiener and Reeve indicate that it lacks a siphonal fasciole, or nearly so.

Turbinella candelabrum Reeve, which was described as coming from Santa Elena, Ecuador, was later cited by Hidalgo, 1904-1905, as occurring in the Philippine Islands.

This species is named for Henry Hemphill, early collector of mollusks on the Pacific coast. Much of his fine collection is now in the Department of Paleontology of the California Academy of Sciences.

Latirus mediamericanus

Hertlein & Strong, sp. nov.

Plate XI, Figs. 3, 10.

Turbinellus acuminatus Kiener, Reeve, Conch. Syst., Vol. 2, 1842, p. 180, pl. 229, fig. 2. [No locality cited].

Not *Turbinella acuminata* Wood, 1828, nor *Turbinella acuminata* Kiener, 1840.

Turbinella castanea Reeve, Conch. Icon., Vol. 4, *Turbinella*, July, 1847, species 26, pl. 5, fig. 26. "Hab. Panama (in the crevices of rocks); Cuming."

Not *Turbinella castanea* Gray, Zool. Beechey's Voy., 1839, p. 114. "Inhab. Pacific Ocean."

Latirus castaneus Reeve, Tryon, Man. Conch., Vol. 3, 1881, p. 91, pl. 68, fig. 138 (copy of Reeve's figure). Panama.

Type Locality: Gorgona Island, Colombia.

Range: Manzanillo, Mexico, to Gorgona Island, Colombia.

Collecting Stations: Costa Rica: Port Parker; Piedra Blanca Bay; Panama: Pearl Islands; Colombia: Gorgona Island.

Description: Typical forms of this attractive west American *Latirus* may be easily recognized by the comparatively smooth, often somewhat flattened whorls, bearing rude, oblique axial plications. The anterior canal is sculptured with about 8 spiral ribs. The earlier whorls bear spiral threads and sometimes the whole shell bears weak or subobsolete spirals. The color is chestnut brown.

The name *Turbinella castanea* was first proposed by Gray in 1839 for a shell which Melvill later referred to the synonymy of *Leucozonia cingulifera* Lamarck. The original description indicates that it is quite

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40 *Turbinella spadicea* Reeve, Conch. Icon., Vol. 4, *Turbinella*, August, 1847, species 44, pl. 9, fig. 44. "Hab.—?"

41 *Latyrus tumens* Carpenter, *Proc. Zool. Soc. London*, November 11, 1856, p. 166. "Hab. In Sinu Panamensi; legit T. Bridges. Sp. un. in Mus. Cuming."—Melvill, *Mem. & Proc. Manchester Lit. & Philos. Soc.*, Ser. 4, Vol. 4, No. 5, 1891, pp. 391, 405, pl. 2, fig. 14 (as *Latirus tumens*) "Amer. centr."—Tomlin, *Jour. Conch.*, Vol. 18, No. 6, 1927, p. 159. Gorgona Island, Colombia, on shore.

42 Hildalgo, J. G., *Mem. R. Acad. Cienc. Fis. y Nat. Madrid*, Vol. 19, 1900, p. 341.

43 Pease, W. H., *Amer. Jour. Conch.*, Vol. 5, Pt. 2, October 7, 1869, p. 83.

44 *Turbinella acuminata* Wood, Index Test., Suppl., 1828, p. 57, pl. 5, fig. 12, As *Murex acuminatus* on p. 15. Habitat unknown.—Kiener, Spéc. Gén. et Icon. Coq. Viv., Canalifères, *Turbinella*, 1840, p. 28, pl. 15, fig. 2. "Habite l'océan Indien."—Reeve, Conch. Icon., Vol. 4, *Turbinella*, 1847, species 47 pl. 9, fig. 47. "Hab. Philippine Islands; Cuming."

different from Reeve's shell of the same name. It therefore becomes necessary to propose a new name for Reeve's *Turbinella castanea* and the name *Latirus mediamericanus* is here proposed. It is based on a holotype from Gorgona Island, Colombia. It measures: height, 52.8 mm.; maximum diameter, 18 mm. A paratype came from Pearl Island, Panama Bay. It measures: length (apex incomplete), 58.3 mm.; maximum diameter, 22 mm. Specimens are often covered with calcareous algae.

Distribution: Several specimens of this species were taken in the region between Port Parker, Costa Rica, and Gorgona Island, Colombia. It also has been recorded as occurring in the Pleistocene of Panama and in the Quaternary of Manta, Ecuador.

Family Buccinidae.

Genus **Pseudoneptunea** Kobelt.

Pseudoneptunea panamica Hertlein & Strong, sp. nov.

Plate II, Figs. 6, 10.

Shell ovately elongate, rather broad, spire moderately elevated, moderately thick, about 7 to 8 whorls which are subangulate at the shoulder; sculpture consisting of longitudinal ridges, about 10 on the penultimate and 9 on the last whorl, these are crossed by spiral lirae of uneven strength but about 10 are noticeable on the lower portion of the last whorl and canal, between these major threads usually 2, occasionally 3, striae are present, where the major threads cross the axial ridges a row of rather sharp spirally elongated tubercles is formed at the angulation, on the penultimate whorl there is another row below the shoulder and on the last whorl there are 2 rows below the shoulder; aperture rather widely subovate, the parietal wall and columella are covered with a thin callus, columella with a slight siphonal fasciole and a slight fold near the base which is slantingly truncated, end of canal slightly recurved, outer lip lirate internally, apparently about 10-12 lirae on the type which is somewhat eroded. Color (paratypes) whitish-brown, the tubercles darker brown and a vague band of that color present on the base of the last whorl. Dimensions of holotype: length, 39 mm.; maximum diameter, 25 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 224, Lat. 7° 23′ 30″ N., Long. 82° 03′ 00″ W., on Hannibal Bank, Panama, in 35-40 fathoms (64-73 meters), bottom of rocks, dead coral, mud, sand, shells, algae. Two specimens, paratypes, were dredged at Station 142-D-3, Lat. 27° 04′ 00″ N., Long. 111° 54′ 00″ W., Santa Inez Bay, Gulf of California, in 40 fathoms (73 meters), sand, weed bottom.

This new species differs from any described shell from west American waters which has come to our attention. It somewhat resembles the east American species described as *Fusus multangulus* Philippi[45]. The shell of the present species is more sharply tuberculate and the spiral threads are much more uneven in strength than those on the species described by Philippi. Both *Fusus multangulus* and the species here described as new appear to be referable to the genus *Pseudoneptunea* Kobelt[46], the type of which was designated by Cossmann[47] as "*Siphon. varicosa*, Kien."[48]

The shell of *Pseudoneptunea panamica* is thinner, the body whorl is more inflated, and lacks the varix on the outer lip, the spiral ribbing is much finer and the axial ribs much more strongly tuberculated than those of *Cantharus vibex* Broderip.

Family Nassariidae.

Genus **Nassarius** Dumeril.

Nassarius insculptus gordanus Hertlein & Strong, subsp. nov.

Plate VIII, Fig. 6.

Typical *Nassarius insculptus* Carpenter[49] has the axial sculpture confined to the first few whorls and the spiral sculpture is strongest on the base. In the subspecies *N. insculptus eupleura* Dall[50] the axial ribs are "prolonged over the periphery of the whorl to the base." The present form also has the axial sculpture quite distinct on the last whorl but the spiral grooves are quite strong over the entire surface, particularly so on the sloping shoulders of the whorls. The shell is darker brown and ranges much farther south than the others which have not been reported south of Cedros Island. The type measures: length, 22 mm.; diameter, 11.5 mm.

Holotype and paratype (Calif. Acad. Sci. Dept. Paleo. Type Coll.) from Station 150-D-6, dredged on Gorda Banks, Gulf of California, in 60 fathoms (109 meters), muddy sand, rocks, Lat. 23° 02′ 00″ N., Long. 109° 31′ 00″ W. In the same general area 2 specimens were dredged at Station 150-D-2, in 75 fathoms (137 meters), sand, Lat. 23° 01′ 00″ N., Long. 109° 28′ 00″ W., and 1 specimen was dredged at Station 150-D-16, in 67-75

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45 *Fusus multangulus* Philippi, *Zeit. f. Malakozool.*, Jahrg. 5, February, 1848, p. 25. "Patria: Yucatan, communicavit cl. Largilliert."—Perry, *Bull. Amer. Paleo.*, Vol. 26, No. 95, 1940, p. 144, pl. 31, fig. 219 (as *Muricidea multangula*. Under subgenus *Pseudoneptunea*).

46 *Pseudoneptunea* Kobelt, Jahrb. deutsch. Malakozool. Gesell., Bd. 9, 1882, p. 17.

47 Cossman, M., Ess. de Paléo., Vol. 4, 1901, p. 111.

48 *Fusus varicosus* Kiener, Spéc. Gén. et Icon. Coq. Viv., Canalifères, Pt. 1, *Fusus*, 1840, p. 41, pl. 10, fig. 2. "Habite les côtes de l'Océanie, celles de l'île Timor." Wenz recorded doubtful occurrence of this species in Peru (Handbuch der Paläozool., Lief. 7, Bd. 6, Gastropoda, Teil 5, 1941, p. 1170, fig. 3324. "Rezent ? bei Peru.)." Oostingh discussed this species and stated that the locality Peru, cited by Deshayes, is probably incorrect (*Mededeel. Landbouwhoogeschool*, Deel 26, Verhandl. 3, 1923, p. 116).

49 *Nassa insculpta* Carpenter, *Rept. Brit. Assoc. Adv. Sci.* for 1863, issued August, 1864, p. 613. "Cat. Is., living in 40 fm., rare", p. 662, Santa Barbara Islands. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, pp. 99, 148. Illustrated by I. S. Oldroyd, *Stanford Univ. Publ. Univ. Ser. Geol. Sci.*, Vol. 2, Pt. 1, 1927, p. 267, pl. 26, fig. 12.

50 *Alectrion insculptus*, new variety *eupleura* Dall, *Proc. U. S. Nat. Mus.*, Vol. 51, No. 2166, January 15, 1917, p. 576. "It has been collected from San Simeon, California, to Cerros Island."

fathoms (122-136 meters), Lat. 23° 02′ 00″ N., Long. 109° 30′ 30″ W.

Family Columbellidae.

Genus *Anachis* H. & A. Adams.

Anachis coronata hannana Hertlein & Strong, subsp. nov.

Plate II, Fig. 3.

Shell small, slender, consisting of 10 slightly rounded whorls including the undifferentiated nucleus, the first 7½ whorls smooth, polished, light brown, with faint lighter dots; the last 2½ whorls developing low, nearly vertical, axial ribs, slightly nodulous at the shoulder of the whorls, while the light dots gradually increase in size until on the last whorl they form narrow, zigzag, white and brown lines of about equal width; of the axial ribs there are about 10 on the last whorl, fading out on the base where they are replaced by about a dozen fine spiral threads extending to the end of the canal; aperture narrow; outer lip thickened, with a sharp edge, internally with 8 spirally elongated denticles, of which the upper is the largest and is separated from the suture by a shallow notch; inner lip with a sharply raised edge; canal short, recurved. Dimensions of holotype: length, 13.6 mm.; maximum diameter, 6.3 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Cape San Lucas, Lower California, Mexico.

The shell of this new subspecies described here is similar to that of *Anachis coronata* Sowerby[51] but differs in the following particulars: the more slender outline, finer and more numerous axial ribs which develop correspondingly weaker coronations at the shoulder of the ultimate and penultimate whorls and in the pronounced color pattern which consists of divaricate stripes of white on a dark brown ground.

Two lots typical of the form here described are present in the Henry Hemphill collection in the California Academy of Sciences, one from Scammon Lagoon and one from Magdalena Bay, Lower California. Judging from the collections which we have studied it appears that this beautifully colored form is characteristic of the northern portion of the range of *Anachis coronata* and it is therefore accorded subspecific rank.

The unique type somewhat resembles a small specimen of *Anachis fluctuata* Sowerby[52] in the peculiarly polished surface and zigzag lines of color but it is more slender and the axial ribs on the body whorl are straight instead of curved.

This subspecies is named for Dr. G. Dallas Hanna, Curator of the Department of Paleontology, California Academy of Sciences.

Anachis ritteri Hertlein & Strong, sp. nov.

Plate II, Fig. 11.

Shell small, solid, ovate, the extreme tip eroded, without distinct nuclear whorls; normal whorls 6, the first 4 nearby smooth, the fifth with faint axial swellings which on the last whorl expand into strong axial ribs extending from the suture to the periphery on the front of the whorl but are faint for some distance back of the lip, other sculpture of rounded spiral cords strongest near the suture, on the base, and canal where they become more closely spaced; outer lip thickened with 3 strong denticles on the posterior portion; columella with 3 equally strong denticles on the anterior portion. Dimensions of holotype: length, 7.4 mm.; diameter, 3.8 mm.

Holotype and paratypes (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, off Port Guatulco, Mexico, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell. About 40 additional specimens were taken with the type. Other specimens were dredged off Tangola-Tangola Bay, Mexico, at Station 196-D-6, 7, Lat. 15° 45′ 34″ N., Long. 96° 06′ 02″ W., and Lat. 15° 45′ 34″ N., Long. 96° 06′ 03″ W., in 6-7 fathoms (11-12.8 meters), sand, crushed shell; Station 196-D-14, 15, Lat. 15° 45′ 34″ N., Long. 96° 06′ 03″ W., in 5 fathoms (9.1 meters), crushed shell.

The color markings on the type are quite striking. Immediately below the suture there is a narrow light band, below this and over the body of the whorl is a darker band, while the base and canal are light again. In addition there are fine penciled spiral lines of dark reddish-brown, 6 appearing on the body whorl. In the paratypes there is much variation in the strength of these colored lines, being entirely absent in some cases. There is much variation in the ribbing, some specimens are nearly smooth, others strongly ribbed. A specimen with poorly developed ribs and strongly developed spiral lines approaches *Anachis incerta* Stearns[53], a somewhat smaller species from the Galapagos Islands.

The shells of the species here described as new bear some resemblance to *Anachis varians* Sowerby[54] originally described as having come from the Galapagos Islands. The present shells are more slender and less shouldered and lack dark coloration at the base of the canal which Tryon stated

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[51] *Columbella coronata* Sowerby, *Proc. Zool. Soc. London*, August 14, 1832, p. 114. "Hab. in Sinu Panamae sub lapidibus."—Sowerby, Thes. Conch., Vol. 1, 1844, p. 135 bis, pl. 39, fig. 134.—Tryon, Man. Conch., Vol. 5, 1883, p. 153, pl. 54, figs. 36, 37.—Baker, Hanna & Strong, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 23, No. 16, 1938, p. 249, pl. 24, fig. 5 (as *Anachis coronata*).

[52] *Columbella fluctuata* Sowerby, *Proc. Zool. Soc. London*, August 14, 1832, p. 115. "Hab. sub lapidibus ad oras Americae Centralis. (Gulf of Nocoiyo)."—Sowerby, Thes. Conch., Vol. 1, 1844, p. 138 bis, pl. 38, fig. 150. Type locality cited.

[53] *Nitidella incerta* Stearns, *Nautilus*, Vol. 6, No. 8, December, 1892, p. 88. "Galapagos Islands (special island not stated), Dr. Simeon Habel."—Stearns, *Proc. U. S. Nat. Mus.*, Vol. 16, No. 942, 1893, p. 390, pl. 51, fig. 6. "Indefatigable Island." Also island not stated, Habel collection.

[54] *Columbella varians* Sowerby, *Proc. Zool. Soc. London*, August 14, 1832, p. 118. "Hab. ad insulas Gallapagos. (Hood's Island.)" Also "Mr. Sowerby has a great number brought by the Endeavor, Capt. Cook, many years since, but without locality."—Sowerby, Thes. Conch., Vol. 1, 1844, p. 117 bis, pl. 37, figs. 47-50.

a characteristic feature of *C. varians*. is coloration is well shown on Sowerby's ures 49 and 50. Specimens agreeing al-ost exactly with Sowerby's illustrations cur in the Hawaiian Islands. Iredale[55] inted out the ambiguity of Sowerby's atement that specimens came from Hood's land, Galapagos group, and that others ithout information as to the locality from hich they came were said to have been col-cted on Captain Cook's voyage on the *ndeavor*. Iredale cited (p. 261) Sowerby's ecies under the name of *Euplica varians* om Middleton Reef off eastern Australia. e stated that it is the species generally eferred to *Columbella varians* on Lord Hood land. Baker, Hanna & Strong, 1938, men-oned that although Sowerby's species was escribed from the Galapagos Islands it ight be confined to more western portions f the Pacific Ocean.

This species is named for Dr. Friedrich itter, once a resident of Charles Island, alapagos Islands.

nachis teevani Hertlein & Strong, sp. nov.
Plate II, Fig. 5.

Shell small, rather slender, extreme tip roken, whorls 7, slightly rounded, moder-tely slopingly shouldered at the summit, culptured with faint axial ribs and equally aint spiral threads strongest on the shoul-er and on the base and canal where about 0 can be counted; aperture narrow, outer ip with 5 small denticles, columella with 4 enticles. The ground color is yellowish-hite with irregular and irregularly placed atches of reddish-brown, 2 of which show hrough on the inside of the outer lip. Di-mensions of holotype: length, 8 mm.; di-meter, 3.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 189-D-4, 17 miles SE. × E. of Acapulco, Mexico, Lat. 16° 38′ 30″ N., Long. 99° 40′ 00″ W., dredged in 28 athoms (51 meters), mud.

If it were not for the faint sculpture and he strong denticles this shell would be much ike *Mitrella tuberosa* Carpenter[56] of the California coast.

This species is named for Mr. John Tee-Van, General Associate, Department of Tropical Research, New York Zoological Society, who accompanied the expedition during which the type of the present species was collected.

Anachis rehderi Hertlein & Strong, sp. nov.
Plate II, Fig. 14.

Shell small, rather slender; nucleus of 3 smooth, glassy whorls; normal whorls 6, flat-sided, sculptured with strong, slightly sinuous axial ribs, about 20 appearing on all whorls, extending from the suture to be-low the periphery, at the suture these ribs are expanded to form a row of raised nodules coronating the whorls; spiral sculpture ab-sent on the spire but strong on the base and canal, 10 cords showing between the peri-phery and the end of the canal; aperture narrow, outer lip thin but probably not ma-ture and without denticles or embayment at the suture, inner lip and columella smooth, with a raised edge. The type is a "dead shell," bleached a dull white but showing very faint indication of colored spiral bands. Dimensions of holotype: length, 8.5 mm.; diameter, 3.3 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, off Port Parker, Costa Rica, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., dredged in 12 fathoms (22 meters), shelly mud. Several additional specimens were taken at the type locality. On some specimens more than 10 spiral cords are present between the periphery and the end of the canal. 1 specimen was dredged at Station 192-D-1, 4 miles SSW. of Mal-danado Point, Mexico. Lat. 16″ 16′ 30° N., Long. 98° 37′ 00″ W., 26 fathoms (47 meters), mud.

This new species bears some resemblance to *Anachis gracilis* C. B. Adams[57] but the presence of a subsutural cord and different color pattern easily serve to separate it from that species.

This species is named for Dr. Harald A. Rehder, Curator of Mollusks, U. S. National Museum.

Genus ***Aesopus*** Gould.

Aesopus osborni Hertlein & Strong, sp. nov.
Plate XI, Fig. 2.

Shell minute, subcylindric, with a blunt, somewhat eroded apex; whorls 6, slightly convex, sutures distinct; sculpture of 22 low, rounded, nearly vertical, axial ribs with slightly wider interspaces; pale brownish with faint white dots on the tops of the ribs arranged in diagonal rows; aperture short, outer lip somewhat thickened, smooth with-in, columella short, smooth; canal short, straight, wide. The type measures: length, 3.0 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand and crushed shell.

As usual in this genus there is much dif-ference in color among a number of speci-mens. Some are nearly white and do not show the diagonal rows of dots. Others are dark brown and show the dots very distinct-ly, the dark areas without magnification ap-pearing as nodules on the ribs.

This species is named for Mr. Fairfield

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55 Iredale, T., *Australian Zool.*, Vol. 8, Pt. 4, March 12, 1937, p. 255.

56 *Amycla tuberosa* Carpenter, *Rept. Brit. Assoc. Adv. Sci.* for 1863, issued August, 1864, pp. 539, 628, 662. Fossil at Santa Barbara, California; Vancouver Island and Straits of Juan de Fuca, and vicinity; region of Mon-terey; region between San Pedro and San Diego, California, and the Santa Barbara Islands.

For additional references to this species see Grant & Gale, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, 1931, p. 697, pl. 26, fig. 45.

57 *Columbella gracilis* C. B. Adams, *Ann. Lyceum Nat. Hist. New York*, Vol. 5, June, 1852, pp. 313, 531 (separate, pp. 89, 307). "Habitat.—Panama."

Osborn, President of the New York Zoological Society.

Genus **Strombina** Mörch.

Strombina marksi Hertlein & Strong, sp. nov.

Plate II, Fig. 7.

Shell small, slender, with a pointed spire, light brown with a few, small, irregular, white spots; nuclear whorls 2, smooth, well rounded, slightly larger than the following whorl; postnuclear whorls 9, slightly shouldered, flattened, the first 5 smooth; beginning with the sixth axial ribs begin to appear, becoming strong on the last two whorls, ribs rounded, strongest on the upper part of the whorls, fading out at the periphery, 9 appearing on the last whorl; spiral sculpture of about a dozen strong threads on the base and canal and a few microscopic striations on the shoulder of the whorls; aperture narrow; outer lip thick with a strong varix externally, internally smooth, shining, with a narrow depression just below the suture; inner lip raised, spreading into a thin callus over the body whorl; canal short, strongly recurved. The type measures: length, 23.8 mm.; maximum diameter, 9.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 136-D-4, Lat. 23° 32′ 00″ N., Long. 109° 27′ 00″ W., dredged in 55 fathoms (100 meters), on Arena Bank, Gulf of California, mud. One additional specimen was dredged at the same locality. Additional specimens were dredged in the Arena Bank area as follows: three specimens at Station 136-D-14, Lat. 23° 29′ 30″ N.. Long. 109° 25′ 00″ W., dredged in 45 fathoms (82 meters), mud; two specimens at Station 136-D-15, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., dredged in 40 fathoms (73 meters), mud, crushed shell; two specimens from Station 136-D-16, Lat. 23° 29′ 30″ N., Long 109° 25′ 30″ W., dredged in 45 fathoms (82 meters), muddy sand, weed; one specimen at Station 136-D-17, Lat. 23° 30′ 30″ N., Long. 109° 26′ 00″ W., dredged in 45 fathoms (82 meters), mud.

The shell of this species bears some resemblance to that of *Strombina recurva* Sowerby[58] but the axial ribs do not rise to points at the periphery of the rounded whorls, the spiral sculpture on the spire is much fainter, the canal is less recurved and the color is lighter. Compared to *Strombina bonita* Strong & Hertlein[59], the present shell has much shorter and less strongly developed axial ribbing. Compared to *Strombina carmencita* Lowe[60], the shell of the present species is much more slender and bears much fewer and weaker spirals.

Strombina gradata Guppy, described from the Bowden Miocene of Jamaica, bears a general similarity to *S. marksi*.

This species is named for Dr. Jay G. Marks, Paleontologist with the Creole Petroleum Corporation, Caracas, Venezuela, in recognition of his contribution to the knowledge of the family Cancellaridae.

Strombinoturris Hertlein & Strong, gen. nov.

Shell slender, turrited, with a thickened varicose outer lip and a long, recurved canal, much the size and shape of the more slender species placed in the genus *Strombina*, but with the shallow depression on the inner portion of the outer lip near the suture shown on those species developed into a deep rounded notch. This notch is thickened and very similar to the anal sulcus in some species of *Clathrodrillia* but it is not armored. Type, *Strombinoturris crockeri* Hertlein & Strong, sp. nov.

Strombinoturris crockeri Hertlein & Strong, sp. nov.

Plate I, Fig. 9.

Shell slender, turrited, dull brownish; nuclear whorls 2, smooth, shining, white; postnuclear whorls 10, slopingly shouldered sutures appressed; axial sculpture on the spire consists of elongated nodules extending from the shoulder to the following suture, 13 appearing on the penultimate whorl, on the last whorl these form sharp nodules at the shoulder and narrower ribs extending to the canal; spiral sculpture of sharp threads, strong on the ribs, fainter in the interspaces, of which 2 appear on the first whorl, increasing to 5 on the penultimate, on the last whorl there are 26 between the shoulder and the end of the canal forming beaded nodules at their intersections with the axial ribs; aperture narrow; outer lip thickened externally by a strong varix, the edge slightly serrated by the spiral sculpture, with a deep, rounded, thick-edged notch just below the suture, the trace of which forms a narrow band in the suture roughened by the curved lines of growth; inner lip and body callus white, glazed, showing the continuation of the spiral threads and with a small callus pile opposite the notch; canal long, open, strongly recurved. The type measures: length, 43.2 mm.; diameter, 14.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 136-D-24, Arena Bank, Gulf of California, Lat. 23° 29′ 00″ N., Long. 109° 23′ 30″ W., dredged in 50 fathoms (91 meters), mud, *Arca* conglomerate. One additional specimen was taken at the type locality. About 15 additional specimens were dredged as follows: Mexico: Arena Bank, Gulf of California (136-D-4, 5, 9, 14, 16, 18, 24, 32), 33-55 fathoms (60-100 meters), mud, muddy sand, weed, *Arca* conglomerate; Santa Inz Bay, east coast of Lower California (142-D-3, 4), 40-50 fathoms (73-91

[58] *Columbella recurva* Sowerby, *Proc. Zool. Soc. London*, August 14, 1832, p. 115. "Hab. ad oras Americae Meridionalis. (Isle of Plata.)" "Found among coral sand at a depth of seventeen fathoms."—Sowerby, Thes. Conch., Vol. 1, 1844, p. 139 bis, pl. 40 (*Columbella*, pl. 5), fig. 152.

[59] *Strombina bonita* Strong & Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 22, No. 6, December 31, 1937, p. 169, pl. 35, fig. 9. "dredged in 20 to 25 fathoms off Cape San Lucas, Lower California, Mexico."

[60] *Strombina carmencita* Lowe, *Trans. San Diego Soc. Nat. Hist.*, Vol. 8, No. 6, March 21, 1935, p. 21, pl. 3, fig. 1. "Carmen Island, Gulf of California, dredged 20 fathoms (1932)."

eters), sand, weed; Gorda Banks off south- rn end of Lower California (150-D-8), 40- 5 fathoms (73-82 meters), muddy sand; osta Rica: off Port Culebra (206-D-3), 14 athoms (25.5 meters), sandy mud; 14 miles . × E. of Judas Point (214-D-1, 4), 42-61 athoms (76.5-112 meters), mud, rocks.

This species appears to be identical with he one collected by Hinds in the Bay of Panama and illustrated by Reeve under the ame of *Pleurotoma stromboides* Sowerby[61]. However, Reeve's illustration apparently epresents a different species than that origi- ally illustrated by Sowerby[62] under the ame of *Pleurotoma stromboides* without in- ormation as to the locality from which it ame. This latter form appears to be the same or nearly the same shell named *Pleurotoma strombiformis* G. B. Sowerby[63] in 1839.

The Recent West American species is here assigned a new name, *Strombinoturris crockeri*, in honor of the late Templeton Crocker, owner of the yacht *Zaca* upon which the expedition was made during which the type of this new species was collected.

The combination of characters of the shell of this species are peculiar in that they are in part those of *Strombina* and in part those of *Clathrodrillia*. Probably a study of the anatomy of the animal will be required to determine the relationship. We place it pro- visionally in the Columbellidae.

Family Muricidae.

Genus **Pterynotus** Conrad.

Subgenus **Pteropurpura** Jousseaume.

Pterynotus (Pteropurpura) swansoni Hertlein & Strong, sp. nov.

Plate II, Figs. 8, 12.

Shell trialate, yellowish-white; nuclear whorls more than 2, apparently smooth; postnuclear whorls 7, roundly shouldered; axial sculpture of 3 flattened, digitated varices between which are low, rounded knobs; spiral sculpture of a low rounded rib on the shoulder which is produced on the varices to long recurved digitations, slightly grooved on the face; on the base 2 similar, smaller spiral ribs are produced as shorter, recurved points; other spiral sculpture of fine striations most prominent on the back of the varices, the front of the varices showing fine fimbriations; aperture ovate with a projecting margin, slightly raised at the junction with the 3 spiral cords but without dentation; canal closed for about two-thirds of its length, curved to the right; operculum thin, brown. The type measures: length, 59 mm.; maximum diameter, including the varices, 49 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 136-D-22, dredged on Arena Bank, Gulf of California, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., in 45 fathoms (82 meters) mud. A second specimen was dredged at Station 142-D-3, in Santa Inez Bay, Gulf of California, Lat. 27° 04′ 00″ N., Long. 111° 54′ 00″ W., in 40 fathoms (73 meters), sand, weed. A juvenile specimen was dredged at Station 146-D-1, also in Santa Inez Bay, Lat. 26° 54′ 20″ N., Long. 111° 48′ 45″ W., in 35 fathoms (64 meters), mud, crushed shell.

The shell of this species is quite similar to that of *Pterynotus petri* Dall[64] from the coast of southern California. It differs in the fewer digitations which extend outward from the shoulder of the whorls rather than upward, also the surface is much smoother.

This species is named for Mr. George Swanson, artist on the expedition, 1936, during which the type specimen was collected.

Genus **Muricopsis** Bucquoy & Dautzenberg.

Muricopsis zeteki Hertlein & Strong, sp. nov.

Plate II, Fig. 9.

Murex aculeatus Wood, Index Test., Suppl., 1828, pp. 15, 44, pl. 5, fig. 19. [No locality cited].

Not *Murex aculeatus* Lamarck, 1822.

Murex dubius Sowerby, Conch. Illustr., *Murex*, 1841, Cat., p. 8, pl. 61, fig. 23. "Panama. Mr. Cuming." New name for *Murex aculeatus* Wood, 1828, not *Murex aculeatus* Lamarck, 1822.—Reeve, Conch. Icon., Vol. 3, *Murex*, 1845, species 116, pl. 26, fig. 116. "Hab. Panama; Cuming."—Sowerby, Thes. Conch., Vol. 4, *Murex*, 1879, p. 43, pl. 403 (*Murex*, pl. 24), fig. 250. Panama.—Tryon, Man. Conch., Vol. 2, 1880, p. 109, pl. 29, fig. 266. Panama.

Not *Murex dubius* Dillwyn, Descript. Cat. Rec. Shells, Vol. 2, 1817, p. 716. "Inhabits—."

Type Locality: Panama City, Panama.

Range: Manzanillo, Mexico (Dall), to the Bay of Panama.

Collecting Stations: Mexico: Port Guatulco (195-D-15), 1.5 fathoms, coral; Costa Rica: Port Parker (203-D-4-15), 1-9 fathoms, sandy mud, cr. shell, shelly sand, algae, shelly mud, rocks, coral, gravel, mangrove leaves, also on beach; Potrero Grande Bay; Piedra Blanca Bay.

Description: Shell elongately ovate, spire rather acuminated, whorls angulated on upper portion, about 6-7 varices present, these where crossed by about 5-6 spiral threads, give rise to sharp spines, between these threads are fine spiral striae, the whole finely squamose; aperture elongately ovate, anterior canal short, slightly recurved, columella obliquely truncated at the base by the canal, often slightly nodose or subplicate, outer lip strongly dentate within, the pos-

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61 *Pleurotoma stromboides* Sowerby, Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, April, 1843, sp. 71, pl. 9, fig. 71. "Hab. Bay of Panama (found in mud at the depth of seven fathoms); Hinds."—Tryon, Man. Conch., Vol. 6, 1884, p. 176, pl. 10, fig. 58 (as *Drillia stromboides*).

62 *Pleurotoma stromboides* Sowerby, Gen. Rec. and Foss. Shells, Vol. 2, [?] 1832, pl. 228, fig. 4.

63 *Pleurotoma strombiformis* G. B. Sowerby, Jun., Conch. Man., 1839, p. 85, fig. 381.

64 *Murex petri* Dall, *Nautilus*, Vol. 14, No. 4, August, 1900, p. 37. "San Pedro, in rather deep water."—Dall, *Proc. U. S. Nat. Mus.*, Vol. 24, No. 1264, 1902, p. 532, pl. 34, fig. 7 (as *Murex (Pteropurpura) petri*). "San Pedro, California, in about 50 fathoms; Oldroyd." See also A. G. Smith in *Min. Conch. Club South. California*, No. 51, August, 1945, pp. 33-34.

terior denticles usually the largest; exterior whitish and brown, the spines and varices darkest, aperture bluish-white, columella sometimes with a brownish tinge on the anterior portion.

The largest specimen in the present collection from Port Parker, Costa Rica, measures: height, 22 mm.; maximum diameter, including spines, 13.3 mm.

The name *Murex dubius* which was applied to this species by Sowerby is not valid because that combination of names had already been applied to a different species by Dillwyn in 1817. We base the new name, *Muricopsis zeteki,* upon a specimen collected by Dr. James Zetek at Panama City, Panama, length, 27.3 mm.; maximum diameter including spines, 18.5 mm. This species is the one illustrated by Reeve (plate 26, fig. 116) from Panama. None of our specimens are as strongly spinose as shown for this species in the illustrations of Sowerby and Reeve. However, in other features they agree well. The subnodose or subplicate character of the lower portion of the columella as well as the strongly dentate inner portion of the outer lip are quite unlike many shells referred to *Murex*. However, Tryon pointed out that the operculum is *Muricoid.* In some features the shell resembles some species of *Engina.*

Muricopsis zeteki differs from *M. squamulata* Carpenter[65] in the lower spire, more nodose or subplicate lower portion of the columella, strongly dentate inner portion of the outer lip and in the darker color.

Muricopsis pauxillus A. Adams[66] appears to be a similar species. According to Tryon's illustration and description of Adams' species it appears to possess a slightly more slender shell with shorter spines and the color was said to be purplish, the revolving ribs usually white.

Distribution: Three specimens, rather small, were dredged by the expedition at Port Guatulco, Mexico, in 1.5 fathoms. It also has been recorded as occurring in the Pleistocene of the Galapagos Islands.

Genus **Trophon** Montfort.

Subgenus **Zacatrophon**

Hertlein & Strong, subgen. nov.

Type: *Trophon* (*Boreotrophon*) *beebei* Hertlein & Strong, *Bull. South. Calif. Acad. Sci.*, Vol. 46, Pt. 2, May-August, 1947 (issued February 5, 1948), p. 80, pl. 18, figs. 1, 2 (on p. 79). Gorda Banks in the southern portion of the Gulf of California, dredged in 60 fathoms.

This subgenus is characterized by the loosely coiled, tabulate whorls which are comparatively smooth externally; sculptured with faint spiral striae, strongest on the base, with somewhat stronger axial growth striae and with a row of sharp, erect, guttered spines on the angulation at the shoulder. Sometimes the spines are slightly extended anteriorly into short lamellae; aperture smooth interiorly; canal moderately long, broad, open; operculum muricoid.

Subgenus **Acanthotrophon**

Hertlein & Strong, subgen. nov.

Type: ***Trophon (Acanthotrophon) sorenseni***

Hertlein & Strong, sp. nov.

The shells of this subgenus are rather thin, biconic in outline; spiral sculpture consisting of 2 or 3 rather weak, usually spinose cords below the shoulder on the body whorl and another one a little more prominent on the canal about halfway between the upper cords and the end of the canal; axial sculpture of weak axially elongated nodes which are developed into a row of sharp, erect, guttered spines on the angulation of the body whorl. The earlier whorls bear a row of nodes rather than spines. A slight siphonal fasciole is present; aperture smooth interiorly.

This subgenus is somewhat similar in general features to *Enixotrophon* Iredale[67] with the type *Trophon carduelis* Watson, an Australian species. *Actinotrophon* Dall[68] appears to belong to quite a different group than *Acanthotrophon.*

Trophon (Acanthotrophon) sorenseni

Hertlein & Strong, sp. nov.

Plate II, Fig. 1.

Shell thin, dingy white; only the last whorl of the nucleus remaining, apparently smooth; postnuclear whorls 6, angulated, sculptured with axially elongated nodes on the upper whorls which on the last whorl are produced into 10 narrow, radial, guttered spines; spiral sculpture consists of 2 faint cords immediately below the shoulder and a third, slightly more prominent, about half way between the upper cords and the end of the canal; aperture ovate; canal narrow, open, distinctly recurved; outer lip thin; inner lip appressed to the base, the enamel terminating some distance from the end of the canal, leaving an umbilical chink. The type measures: length, 31 mm.; length of aperture and canal, 19 mm.; maximum diameter (not including spines), 14 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 150-D-24, Lat. 23° 01′ 00″ N., Long. 109° 29′ 00″ W., dredged on Gorda Banks, southern portion of the Gulf

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[65] *Muricidea dubia* var. *squamulata* Carpenter, *Proc. Zool. Soc. London*, March 14, 1865, p. 281. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, p. 274. "Hab. Cape St. Lucas (Xantus)."—M. Smith, Illustr. Cat. Rec. Spec. Rock Shells (Trop. Labor., Lantana, Florida), 1939, p. 11, pl. 12, fig. 6 (as *Muricidea dubius squamulata* Carpenter and *Muricidea squamulifera* Pfeiffer).

[66] *Murex pauxillus* A. Adams, *Proc. Zool. Soc. London* for 1853, p. 71 (issued July 25, 1854). "Hab. Gulf of California."—Tryon, Man. Conch., Vol. 2, 1880, p. 109, pl. 29, fig. 264. "Mazatlan." Mexico.

[67] *Enixotrophon* Iredale, *Rec. Australian Mus.*, Vol. 17, No. 4, September 4, 1929, pp. 185, 189. "type *Trophon carduelis* Watson." (See Rept. Sci. Res. Voy. *Challenger*, Zool., Vol. 15, 1886, Gastropoda, p. 167, pl. 10, fig. 7. Dredged off Sydney, Australia, in 410 fathoms).

[68] *Actinotrophon* Dall, *Proc. U. S. Nat. Mus.*, Vol. 24, No. 1264, March 31, 1902, p. 541. Sole species *Boreotrophon actinophorus* Dall (*Bull. Mus. Comp. Zool.*, Vol. 18, June, 1889, p. 206, pl. 15, fig. 2. Caribbean region, off Santa Cruz in 248 fathoms; off Martinique in 170 fathoms; near Barbados in 140 fathoms.)

of California, in 60 fathoms (109 meters), sand, calcareous algae.

The interior of the unique type has the appearance of a fresh shell but the exterior appears weathered and worn. Spines may have been present originally on the upper whorls.

This new species bears some resemblance to "*Murex*" *carduus* Broderip[69] originally described from Pacasmayo, Peru, but it has but a slight umbilical groove, the canal is more elongate, much more pointed, and it lacks the numerous spiral rows of spines on the body whorl and canal which are so prominent on Broderip's species. The shell is similar in shape to *Trophon avalonensis* Dall[70], described from off Avalon, Catalina Island, California, but is larger, lacks the varicose lamellae present on that species and the spines are longer and narrower.

This species is named for Mr. Andrew Sorensen of Pacific Grove, California, who has assiduously collected marine mollusks in the Gulf of California.

Genus **Calotrophon**
Hertlein & Strong, gen. nov.
Type: **Calotrophon bristolae**
Hertlein & Strong, sp. nov.

Shell subfusiform, whorls subangulated, sculptured with rounded axial ribs which begin at the angulation and extend to the following suture on the spire, to the base on the body whorl; spiral sculpture of rather coarse cords, the first one, beginning at the angulation, forms low vaulted scales where it crosses the axial ribs, the remainder are squamosely scaly; outer lip with spirally elongated denticles; canal short, open, somewhat recurved at the end, a well developed siphonal fasciole present.

The very strong axial ribs with vaulted scales at the angulation, strong spiral cords and dentate interior of the outer lip are features separating this genus from *Boreotrophon*.

The scaly sculpture of the spiral ribs of this genus is somewhat reminiscent of *Xenotrophon* Iredale[71] with the type *X. euschema*, an Australian species.

Benthoxystus Iredale[72] with the type *Trophon columnarius* Hedley & May, has sculpture somewhat lattice-like in pattern vaguely resembling that of *Trophon boivinii* Kiener, 1843 (*Murex horridus* Broderip, 1833, not of Brocchi, 1814). *Trophon columnarius* has, however, a very high spire and differs in other details from the west American shell.

Calotrophon bristolae
Hertlein & Strong, sp. nov.
Plate II, Fig. 2.

Shell fusiform, white, fairly thick; nuclear whorls decollated; postnuclear whorls 7, slopingly shouldered; axial sculpture consisting of nearly vertical, rounded ribs, extending from the shoulder to the following suture on the spire and becoming slightly less strong over the base, 10 present on the last whorl; spiral sculpture consists of a cord on the shoulder which rises to small, vaulted scales where it rides over the ribs, followed by 2 similar, smoother cords between the shoulder and the suture on the spire and 6 more on the base and canal; all spiral cords show a tendency to form vaulted scales, both on crossing the ribs and in the interspaces, particularly in the area immediately back of the edge of the outer lip; aperture ovate, thin at the edge, thickened within where it bears 5 spirally elongate denticles; canal short, open, slightly recurved; inner lip appressed to the base except at the lower end where it bounds a distinct siphonal fasciole. The type measures: length, 39 mm.; length of aperture and canal, 22 mm.; maximum diameter, 20 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo, Type Coll.), from Station 150-D-24, Lat. 23° 01′ 00″ N., Long. 109° 29′ 00″ W., dredged on Gorda Banks in the southern portion of the Gulf of California in 60 fathoms (109 meters), sand, calcareous algae. 1 additional specimen was taken at the type locality. Several specimens were dredged in the vicinity of the type locality as follows: 1 at Station 150-D-6, in 60 fathoms (109 meters), muddy sand, rocks; 2 at Station 150-D-13, in 70-80 fathoms (128-146 meters), sand, calcareous algae; 6 at Station labeled 150-D-27 but that haul number is erroneous because no haul with that number was recorded from Station 150.

The general features of this species are somewhat similar to those of *Trophon boivinii* Kiener[73] (*Murex horridus* Broderip[74], 1833, not *Murex horridus* Brocchi, 1814), which was originally described from Ecuador and Panama. The present shell differs in that the spiral cords are much more closely

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69 *Murex carduus* Broderip, *Proc. Zool. Soc. London* for 1832, p. 175 (issued January 14, 1833). "Hab. in oceano juxta Pacosmayo Peruviae." "From a coral reef twelve miles from the land, at the depth of twenty-five fathoms."—Reeve, Conch. Icon., Vol. 3, *Murex*, 1845, sp. 125, pl. 28, fig. 125.

70 *Boreotrophon avalonensis* Dall, *Proc. U. S. Nat. Mus.*, Vol. 24, No. 1264, March 31, 1902, p. 546. "Dredged off Avalon, in the Santa Barbara channel, California, by the U. S. Fish Commission steamer *Albatross*, at station 3664, in 80 fathoms, sand, bottom temperature 50° F.; U. S. N. M., 109109."—Dall, *U. S. Nat. Mus.*, *Bull.* 112, 1921, p. 110, pl. 8, fig. 8 (as *Neptunea avalonensis*).

71 *Xenotrophon* Iredale, *Rec. Australian Mus.*, Vol. 17, No. 4, September 4, 1929, pp. 184, 189. "Type *Xenotrophon euschema* Iredale," p. 184, pl. 40, fig. 3. "Type trawled off Montague Island, New South Wales, 50-60 fathoms."

72 *Benthoxystus* Iredale, *Rec. Australian Mus.*, Vol. 17, No. 4, September 4, 1929, pp. 185, 189. "type *Trophon columnarius* Hedley & May. (See *Rec. Australian Mus.*, Vol. 7, No. 2, September 11, 1908, p. 121, pl. 24, fig. 22. Dredged 7 miles East of Cape Pillar, Tasmania, in 100 fathoms.

73 *Murex boivinii* Kiener, Spéc. Gén. et Icon. Coq. Viv., Fam. Canalifères, *Murex*, 1843, p. 81, pl. 43, fig. 2. "Habite."

74 *Murex horridus* Broderip, *Proc. Zool. Soc. London* for 1832, p. 176 (issued January 14, 1833). "Hab. ad Sanctam Elenam et ad Panamam." "Found in sandy mud at the depth of from eight to twelve fathoms."—Reeve, Conch. Icon., Vol. 3, *Murex*, 1845, species 128, pl. 28, fig. 128. Original locality cited.

The combination of names *Murex horridus* used by Broderip in 1833 had already been used by Brocchi in 1814. The specific name *boivinii* of Kiener thus becomes applicable to the species described by Broderip.

spaced, not forming a latticed pattern, and the interspaces are not striated as in Broderip's species. The spiral cords on this new species are often somewhat irregularly spaced and occasionally a small spiral thread occurs between the major cords, especially on the upper portion of the whorl just below the shoulder.

This species is named for Miss Viola Bristol, Curator of Mollusks, San Diego Society of Natural History.

Superfamily Ptenoglossa.

FAMILY EPITONIIDAE.

Genus **Epitonium** Bolten.

Subgenus **Asperiscala** De Boury.

Epitonium (Asperiscala) vivesi Hertlein & Strong, sp. nov.

Plate III, Fig. 11.

Shell small, thin, pure white; nuclear whorls 3, well rounded, smooth; postnuclear whorls 8, well rounded with deep sutures, regularly increasing in size; axial sculpture of 7 strong, varicose ribs, continuous up the spire about which they make nearly a full turn, strongly reflected, exposing the edges of the cell-structure as axial striations, forming long, curved, coronating points at the shoulder, beyond which they dip concavely into the sutures; spiral sculpture of numerous fine, distant striations which are distinct on the upper whorls but gradually fade out until on the last whorl they are scarcely discernible; ribs continuous over the base without cord or disk, fusing with the raised inner lip; aperture nearly circular, the outer and basal lips thickened by the last varicose rib. The type measures: length, 7.0 mm.; maximum diameter, 3.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 145-D-1-3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters), sand. 5 additional but younger specimens were dredged at the same locality.

The strongly coronating points and fewer varicose ribs of this species make it quite distinct from any west coast species described in the subgenus *Asperiscala. Epitonium* (*Nitidiscala*) *apiculatum* Dall[75] is about the same size and shape for the same number of whorls and has about the same number of varicose ribs, but it lacks the spiral sculpture and the ribs are more erect with less coronation.

This species is named for Mr. Gastón J. Vives, native of La Paz, Lower California, who developed a method for cultivating the West American pearl oyster, *Pinctada mazatlanica.*

Epitonium (Asperiscala) manzanillense Hertlein & Strong, sp. nov.

Plate III, Fig. 13.

Shell small, pure white, broadly conic; nuclear whorls 4, smooth, elevated, horn-colored, separated from the first postnuclear whorl by a sharp line; postnuclear whorls 5, well rounded, separated by a deep suture, rapidly increasing in size; axial sculpture of 16, thin, erect, sharp edged varices, without spine or angulation, curving into the suture where they meet and fuse, continuous over the spire which they about half encircle, on the imperforate base continuing without change to the edge of the columellar lip; spiral sculpture of raised threads in the interspaces between the varices, about 12 appearing on the last whorl; aperture nearly circular with a broad outer lip slightly expanded anteriorly. The type measures: length, 3.7 mm.; diameter, 1.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 184-D-2, Lat. 19° 04′ 00″ N., Long. 104° 22′ 00″ W., near Manzanillo, Mexico, dredged in 30 fathoms (55 meters), gravelly sand.

In shape and sculpture this shell resembles *Epitonium* (*Asperiscala*) *bellastriatum* Carpenter from the California coast but is smaller for the same number of whorls and lacks the coronation of the varices and umbilicus of that species. The unique specimen is probably not mature.

Epitonium (Asperiscala) walkerianum Hertlein & Strong, sp. nov.

Plate III, Fig. 12.

Shell small, pure white, elongate-conic; nuclear whorls 4, smooth, white, forming an elevated spiral point to the shell without noticeable break in the outline; postnuclear whorls 5, rounded, separated by a distinct but rather shallow, rounded suture; axial sculpture of 20 low, rounded ribs, without spine or angulation, curving into the sutures where they meet and fuse, continuous over the spire which they nearly encircle, on the imperforate base continuing without change to the edge of the columellar lip; spiral sculpture of sharp, incised lines in the interspaces between the axial ribs, about 12 appearing on the last whorl; aperture nearly circular, with the outer lip but little thickened and narrower than the columellar lip. The type measures: length, 3.7 mm.; diameter, 1.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves. Additional specimens were collected in beach drift at Corinto.

Epitonium (*Asperiscala*) *onchodes* Dall[76], from Panama Bay in 62 fathoms, seems from the description to be a somewhat similar

[75] *Epitonium apiculatum* Dall, *Proc. U. S. Nat. Mus.*, Vol. 53, No. 2217, August 10, 1917, p. 480. "Range, Lower California to Panama Bay, in 30 fathoms."—Baker, Hanna & Strong, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 19, No. 5, 1930, p. 51, pl. 3, figs. 4, 5, 6 (as *Epitonium* (*Nitidoscala*) *apiculatum*).

[76] *Epitonium* (*Asperoscala*) *onchodes* Dall, *Proc. U. S. Nat. Mus.*, Vol. 53, No. 2217, August 10, 1917, p. 476. "Range, Panama Bay in 62 fathoms, sand."

hell but the sutures are said to be deep and he base minutely perforate.

This species is named for William Walker, ne time president of Nicaragua.

Subgenus **Cirsotrema** Mörch.

Epitonium (Cirsotrema) togatum

Hertlein & Strong, sp. nov.

Plate III, Figs. 1, 5.

Shell of medium size, with a slender, turited spire, dingy white; nuclear and probably the first 1 or 2 postnuclear whorls lost; emaining whorls 10, narrowly tabulated, with deep sutures, regularly increasing in size, the upper whorls with the sculpture much worn; axial sculpture of (on the last whorl 20) retractive, strongly reflected ribs, continuous from suture to suture, of which every fourth, fifth or sixth is swollen to form a strong varix; spiral sculpture of 7 cords in the interspaces between the axial ribs and numerous fine striae; the reflected faces of the varices with close, waved, axial striae, that of the intermediate axial ribs below the slightly coronated shoulder with 3 or more sharp, waved, axial laminae, the points of which correspond to the spiral cords, and in some cases span the interspaces between the axial ribs; base with a strong spiral cord forming a narrow basal disk, the axial ribs expanded on the cord but become narrow where they fuse with the inner lip; aperture circular, the outer and basal lip thickened by the last varix. The type measures: length, 37.5 mm.; maximum diameter, including the varices, 13.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 150-D-19, Lat. 23° 01′ 00″ N., Long. 109° 27′ 30″ W., Gorda Banks, Gulf of California, dredged in 50 fathoms (91 meters), sand. A second specimen was secured at the same locality.

Two specimens, apparently the same species although varying somewhat from the type specimen, were taken, one at Station 184-D-2, Lat. 19° 04′ 00″ N., Long. 104° 22′ 00″ W., near Manzanillo, Mexico, dredged in 30 fathoms (55 meters), gravelly sand, and one at Station 214-D-1-4, Lat. 9° 19′ 32″ N., Long. 84° 29′ 30″ W., to Lat. 9° 17′ 40″ N., Long. 84° 27′ 30″ W., 14 miles S. × E. of Judas Point, Costa Rica, dredged in 42-61 fathoms (76.5-112 meters), mud, shell, rocks.

The shell of this species appears to be quite distinct from any other known from the west coast. It is quite similar to the shell illustrated by Dall[77] under the name of *Scala* (*Cirsotrema*) *cochlea* Sowerby from the northern part of the Gulf of Mexico, but is more slender, with more numerous axial ribs. The figure of "*Scalaria*" *cochlea* Sowerby[78], a species said to have come from Loanda, West Africa, is more slender than our shell, with more rounded whorls. Two west American species referred to *Cirsotrema* do not appear to belong to that subgenus. *Scala* (*Cirsotrema*) *montereyensis* Dall[79] is the young of a typical *Opalia* and the unfigured *Cirsotrema funiculata* Carpenter[80] also appears to be an *Opalia* according to the description.

Subgenus **Nitidiscala** De Boury.

Epitonium (Nitidiscala) oerstedianum

Hertlein & Strong, sp. nov.

Plate III, Fig. 10.

Shell small, short, white, with the whorls rapidly increasing in size; nuclear whorls 4, smooth, well rounded, with a narrow brown line in the sutures; postnuclear whorls 6, swollen, with very deep sutures; axial sculpture of 7 high, somewhat reflected, varicose ribs, with finely striated anterior faces, continuous up the spire, about which they make nearly two-thirds of a turn; at the shoulder of the whorls the ribs are expanded to form broad, coronating points, beyond which they dip concavely toward the suture, which they span to fuse with the corresponding rib on the preceding whorl, leaving deep pits in the suture; ribs continuous over the base and fusing with the expanded inner lip; spiral sculpture absent; aperture nearly circular, a broad margin formed by the last rib, produced at the shoulder and at the junction of the basal and inner lips. The type measures: length, 6.5 mm.; maximum diameter, 4.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 145-D-1-3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters), sand.

In many ways the unique type agrees with the description of the unfigured *Epitonium bialatum* Dall[81] but is less than half the length for the same number of whorls and has an entirely different nucleus.

This species is named for Dr. Anders Sandoe Oersted, Danish botanist, whose collection of mollusks from the west coast of Central America in 1847 was described by Dr. O. A. L. Mörch.

Epitonium (Nitidiscala) durhamianum

Hertlein & Strong, sp. nov.

Plate III, Fig. 9.

Shell small, elongate-conic, white; nuclear whorls 4, pale horn color, smooth, forming an elevated spiral point to the spire without noticeable break to the outline; postnuclear whorls 7, the upper third of each whorl

[77] *Scala* (*Cirsotrema*) *cochlea* Sowerby, Dall, *Proc. U. S. Nat. Mus.*, Vol. 24, No. 1264, 1902, p. 506, pl. 30, fig. 7. Gulf of Mexico. Also cited from the West Indies and off Cape Hatteras, North Carolina, and near Cedar Keys, Florida.

[78] *Scalaria cochlea* Sowerby, Thes. Conch., Vol. 1, *Scalaria*, p. 103 bis, pl. 35, fig. 142, April 11, 1844. "From Loanda, West coast of Africa."

[79] *Scala* (*Cirsotrema*) *montereyensis* Dall, *Nautilus*, Vol. 20, No. 11, March, 1907, p. 128. "Dredged in 25 fathoms mud, off Del Monte, in Monterey Bay, Cala." Keen has pointed out that this species should take the name *Epitonium regiomontanum* Dall in De Boury (See *Min. Conch. Club. South. Calif.*, No. 52, September, 1945, p. 31).

[80] "*Cirsotrema funiculata*, ? n. s.," Carpenter, Cat. Mazatlan Shells, January, 1857, p. 447. "Hab.-Mazatlan; 2 sp. only." Also cited from Panama.

[81] *Epitonium bialatum* Dall, *Proc. U. S. Nat. Mus.*, Vol. 53, No. 2217, August 10, 1917, p. 485. "Range, Gulf of California, near La Paz, in 10 fathoms, and West Mexico."

broadly, slopingly shouldered, the lower third well rounded, separated by a moderately deep suture; axial sculpture of 16 low, narrow, slightly reflected ribs, without spine or angulation, curving into the sutures where they meet and fuse, continuous over the spire which they nearly encircle, on the imperforate base continuing without change to the columellar lip; spiral sculpture absent; aperture oval, outer and columellar lips only moderately thickened. The type measures: length, 5.7 mm.; diameter, 1.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), bottom of mangrove leaves. Additional specimens were collected in beach drift at Corinto.

The sloping shoulder on the whorls of this species would seem to be a distinct character separating it from all species described from the west coast of approximately this size and with approximately this number of varices.

This species is named for Dr. J. Wyatt Durham, Associate Professor of Paleontology, University of California, Berkeley, California.

Subgenus **Punctiscala** De Boury.

Epitonium (Punctiscala?) colimanum

Hertlein & Strong, sp. nov.

Plate III, Fig. 14.

Shell small, elongate-conic, white; nuclear whorls with the tip broken, the two remaining whorls well rounded, rapidly enlarging, the first smooth, the second axially threaded; postnuclear whorls 6, well rounded, separated by a deep suture; axial sculpture of 10 strong, somewhat retractive, rounded ribs which hardly touch in the sutures where they alternate in most cases, interspaces rounded, wider than the ribs; base forming a distinct disk at the upper edge of which both ribs and interspaces terminate; entire surface with fine, wavy, spiral striations which continue over the tops of the ribs and show on the basal disk where they extend to the umbilical region; aperture round, outer lip thickened by the last rib, forming a flattened face with a slightly raised inner edge, columellar lip similarly raised but not as wide as the outer lip. The type measures: length, 7.6 mm.; diameter, 2.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 184-D-2, Lat. 19° 04′ 00″ N., Long. 104° 22′ 00″ W., near Manzanillo, Mexico, dredged in 30 fathoms (55 meters), gravelly sand.

The shell of this species differs from that of *Epitonium carpenteri* Tapparone-Canefri[82], from the Gulf of California, in that it possesses 10 rather than 8 axial ribs.

Subgenus **Sthenorytis** Conrad.

Epitonium (Sthenorytis) paradisi

Hertlein & Strong, sp. nov.

Plate III, Fig. 7.

Shell turbinate, pure white; nuclear whorls and first 2 postnuclear whorls lost; remaining whorls 6, rapidly enlarging, well rounded, sutures deep; axial sculpture of varicose ribs, erect on the upper whorls, somewhat reflected on the lower whorls, expanded to form coronating points on the shoulder, depressed in the suture and confluent near the aperture, with axial striations on the faces; of these ribs there are [illegible] on the upper whorls and 10 on the last whorl, in general continuous up the spire about which they make nearly a full turn, the increasing number of ribs occurring as occasional splits in the sutures; aperture round with a broad face except for a short distance along the body of the whorl; at the lower end of the columella the lip is somewhat depressed and expanded but not forming a basal disk. The type measures: length, 3[illegible] mm.; maximum diameter, including varicose ribs, 26.5 mm., not including ribs, 18 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 150-D-13, Lat. 23° 01′ 00″ N., Long. 109° 27′ 30″ W., Gorda Banks, Gulf of California, dredged in 70-80 fathoms (128-146 meters), sand, calcareous algae. A second specimen was dredged at the same locality. One specimen, somewhat eroded, was taken at Station 136-D-13, Lat. 23° 29′ 00″ N., Long. 109° 24′ 00″ W., Arena Bank, dredged in 45 fathoms (82 meters), mud, *Arca* conglomerates.

In many ways this species resembles *Epitonium* (*Sthenorytis*) *turbinum* Dall[83], known only by the basal whorl of a specimen dredged off the Galapagos Islands. The more erect form, less oblique aperture and different shape of the varicose axial ribs indicate that the present specimens represent a distinct species. *Epitonium* (*Sthenorytis*) *pernobilis* Fischer & Bernardi[84], an Atlantic species, is very similar to *E. paradisi*.

Superfamily Gymnoglossa.

Family Eulimidae.

Genus **Balcis** Leach.

Subgenus **Balcis** s.s.

Balcis (Balcis) corintonis

Hertlein & Strong, sp. nov.

Plate VI, Fig. 1.

Shell minute, elongate-conic, slender, straight, translucent, white; whorls 8, slightly rounded, in places showing strong lines of growth, in other places wide smooth areas resembling varices but not raised; sutures

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[82] *Scalaria carpenteri* Tapparone-Canefri, *Journ. de Conchyl.*, Vol. 24, No. 2, 1876, p. 154. New name for *Scalaria raricostata* Carpenter (Cat. Mazatlan Shells, January, 1857, p. 447. "Hab.-Mazatlan; 1 sp. off Chama."). Not *Scalaria raricostata* Wood, 1828.

[83] *Epitonium* (*Sthenorhytis*) *turbinum* Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 317, pl. 9, figs. 5, 6, 8. From "four miles S. 41° E. from the east point of Hood Island, Galapagos Islands, in 300 fathoms, broken shell, bottom temperature 48.6° F".

[84] See Clench, W. J., and Turner, R. D., *Johnsonia*, Vol. 2, No. 29, September 30, 1950, p. 224, pl. 97, figs. 1-7. Range, North Carolina south through the Lesser Antilles.

uite distinct; periphery rounded, base somewhat produced; aperture large, oval, outer ip produced in the middle, inner lip short, reflected and closely appressed to the base, parietal wall with a slight callus. The type measures: length, 1.9 mm.; diameter, 0.7 mm. The specimen is probably not fully mature.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, in 12-13 fathoms (22-24 meters), mangrove leaves. About a half dozen additional specimens, some of them somewhat worn, were dredged at the type locality.

The shell of this new species is exceedingly slender in comparison to that of somewhat similar species such as *Balcis solitaria* C. B. Adams[85].

Subgenus **Vitreolina** Monterosato.

Balcis (Vitreolina) drangai

Hertlein & Strong, sp. nov.

Plate VI, Fig. 2.

Shell small, elongate-conic, white, doubly flexed, almost the entire shell curved strongly to the right, the tip bent forward; whorls 11, the first 3 slightly rounded, the rest flattened; sutures rather distinct but with the preceding whorls shining through in some lights, giving the appearance of a false suture; periphery rounded, base moderately produced, slightly rounded; aperture small, ovate, outer lip fairly thick, produced in the middle, inner lip short, reflected and appressed to the base, parietal wall with a moderate callus. The type measures: length, 3.3 mm.; diameter, 1.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, in 7 fathoms (12.6 meters), gr. sand, crushed shell. Four additional specimens, slightly worn, were dredged at the type locality.

The shell of this species is considerably wider in proportion to the height in comparison with that of *Balcis taravali* Bartsch[86] which is exceedingly slender.

This species is named for Mr. Ted Dranga of Miami, Florida, a well known collector of marine mollusks.

FAMILY PYRAMIDELLIDAE.

Genus **Turbonilla** Risso.

Subgenus **Bartschella** Iredale.

Turbonilla (Bartschella) vestae

Hertlein & Strong, sp. nov.

Plate VI, Fig. 4.

Shell elongate-ovate, white; nucleus large, having a depressed helicoid spire, with the axis forming an oblique angle with that of the following whorls, in the first of which it is about one-half immersed; normal whorls 7, strongly, slopingly shouldered, flattened below the shoulder angle; axial ribs straight, slightly retractive, 18 appearing on the first whorl, increasing to 24 on the last whorl; interspaces wider than the ribs, crossed by 5 spiral series of pits, the raised areas between which appear as wider, flat-topped cords, of which the one at the shoulder angle is somewhat sharper than the others and forms small tubercles at the intersection with the axial ribs; periphery rounded, marked by a cord similar to those on the spire; base rounded, with 6 spiral cords of which the upper two are interrupted by the enfeebled extensions of the axial ribs; aperture ovate, outer lip thin, columella curved, not raised. The type measures: length, 3.1 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

This species bears a resemblance to *Turbonilla (Bartschella) hipolitensis* Dall & Bartsch[87] but it differs from that species in possessing tuberculate spiral cords at the shoulder of the whorls.

The specific name of this species is derived from that of the brig *Vesta* on which William Walker and his 58 "immortals" sailed to Realejo, Nicaragua, in 1855.

Subgenus **Careliopsis** Mörch.

Turbonilla (Careliopsis) beltiana

Hertlein & Strong, sp. nov.

Plate VI, Fig. 3.

Shell elongate-conic, slender, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is slightly immersed; normal whorls 7, slightly rounded, somewhat contracted just below the suture, the first nearly smooth, the rest with microscopic spiral threads of which 8 appear on the first whorl, increasing to 14 on the last whorl; axial sculpture of very fine lines which render the spiral threads slightly granular and the interspaces with faintly indicated pits; periphery rounded, without definite markings; base rather long, rounded, with 8 spiral threads similar to those on the spire; aperture ovate, outer lip thin, columella short, curved. The type measures: length, 3.2 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua.

The shell of this species differs from that of *Turbonilla (Careliopsis) stenogyra* Dall & Bartsch[88] in that the spiral sculpture con-

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85 *Eulima solitaria* C. B. Adams, *Ann. Lyceum Nat. Hist. New York*, Vol. 5, July, 1852, pp. 423, 542 (separate pp. 199, 318). "Taboga" Island, Panama. "On Holothuriae."—Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 53, No. 2207, 1917, p. 308, pl. 35, fig. 4 (as *Melanella (Melanella) solitaria*).

86 *Melanella (Balcis) taravali* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 53, No. 2207, August 13, 1917, p. 328, pl. 42, fig. 2. "Point Abreojos, Lower California."

87 *Turbonilla (Dunkeria) hipolitensis* Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, December 13, 1909, p. 123, pl. 12, figs. 8, 8a. "from San Hipolito Point, Lower California."

88 *Turbonilla (Careliopsis) stenogyra* Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, December 13, 1909, p. 130, pl. 12, figs. 1, 1a. "San Hipolito Point, Lower California."

sists of finely granular threads rather than of a series of impressed pits.

This species is named for Thomas Belt, author of *The Naturalist in Nicaragua.*

Subgenus **Chemnitzia** d'Orbigny.

Turbonilla (Chemnitzia) nicarasana Hertlein & Strong, sp. nov.

Plate VI, Fig. 8.

Shell elongate-conic, white; nucleus having an elevated spire with the axis at right angles to that of the following whorls, the tip extending slightly beyond the edge of the first whorl, in which it is about one-third immersed; normal whorls 11, moderately rounded; axial ribs rounded, slightly curved, strongly protractive; interspaces smooth, about twice as wide as the ribs, terminating a little above the periphery, leaving a narrow smooth band in the suture; periphery subangulated, base short, rounded; aperture subquadrate, outer lip thin, columella nearly straight, somewhat reflected over the umbilical area. The type measures: length, 5.2 mm.; diameter, 1.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

The shell of this species differs from that of *Turbonilla* (*Chemnitzia*) *sinaloana* Strong[89] in that the periphery of the body whorl is subangulated rather than well rounded.

The specific name of this species is derived from that of Nicaras, a powerful Cholutec Chief in Nicaragua.

Subgenus **Cingulina** A. Adams.

Turbonilla (Cingulina) realejoensis Hertlein & Strong, sp. nov.

Plate V, Fig. 2.

Shell small, elongate-conic, vitreous, nucleus deeply, obliquely immersed in the first of the following whorls above which only the tilted edge appears; normal whorls 6, with the greatest diameter at about the lower third where they are angulated, almost flat above and below the angle; spiral sculpture of a low cord just below the suture and a second on the angle, bounded by shallow grooves; entire surface with microscopic spiral lines; axial sculpture of faint indications of ribs, most noticeable on the upper whorls, and very fine lines of growth; periphery rounded, without definite marking; base rather long, well rounded, marked with numerous microscopic spiral striations and stronger lines of growth; aperture ovate, outer lip thin, showing the spiral cord within, columella very slender. The type measures: length, 2.7 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Corinto, Nicaragua, collected in beach drift.

The shell of this species differs from that of *Turbonilla* (*Cingulina*) *academica* Strong & Hertlein[90] in that the penultimate whorl is sculptured with 2 rather than 3 spiral cords.

Subgenus **Mormula** A. Adams.

Turbonilla (Mormula) guatulcoensis Hertlein & Strong, sp. nov.

Plate VI, Fig. 9.

Shell elongate-conic, light brown; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-half immersed; normal whorls 8, narrowly shouldered, well rounded, with here and there slight varicose swellings; axial ribs low, irregular, sinuous, somewhat retractive, 24 appearing on the first whorl, increasing to about 40 on the last whorl; interspaces varying in width, crossed by numerous fine, incised spiral lines; periphery without definite markings, base produced, the axial ribs fading out in the umbilical region, with spiral sculpture similar to that on the spire except that on the lower half the incised spiral lines continue over the enfeebled axial ribs; outer lip decidedly thickened, aperture oval, columella short, strongly curved, body with a distinct callus. The type measures: length: 5.9 mm.; diameter, 1.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The shell of this species differs from that of *Turbonilla* (*Mormula*) *coyotensis* Baker, Hanna & Strong[91] in that the base is produced rather than short.

Subgenus **Ptycheulimella** Sacco.

Turbonilla (Ptycheulimella) portoparkerensis Hertlein & Strong, sp. nov.

Plate VI, Fig. 10.

Shell elongate-conic, very slender, pale brown; nucleus and several of the upper whorls decollated; axial ribs faint, irregular and irregularly spaced, entire surface with incised spiral lines, about 20 on each whorl; periphery subangulated, base short, with incised spiral lines similar to those on the spire; aperture subquadrate, outer lip thin, columella short, straight, somewhat reflected. The remaining whorls of the type measure: length, 7.3 mm.; diameter, 1.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port

[89] *Turbonilla* (*Chemnitzia*) *sinaloana* Strong, *Bull. South. Calif. Acad. Sci.*, Vol. 48, Pt. 2, May-August (issued November 4), 1949, p. 73, pl. 12, fig. 2. "Mazatlan, Mexico."

[90] *Turbonilla* (*Cingulina*) *academica* Strong & Hertlein, Allan Hancock Pac. Exped., Vol. 2, No. 12, August 21, 1939, p. 205, pl. 19, fig. 14. "dredged in from 3 to 9 fms. in Bahia Honda, Panama."

[91] *Turbonilla* (*Mormula*) *coyotensis* Baker, Hanna & Strong *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 17, No. 7, June 29, 1928, p. 223, pl. 11, fig. 17. "Coyote Bay, Concepcion Bay, Lower California, in about two fathoms."

rker, Costa Rica, dredged in 12 fathoms 2 meters), shelly mud.

The shell of this species differs from that Turbonilla (Ptycheulimella) magdalin- sis Bartsch[92] in that the spiral sculpture nsists of incised lines rather than of ex- edingly fine striations.

Subgenus **Pyrgisculus** Monterosato.

Turbonilla (Pyrgisculus) utuana

Hertlein & Strong, sp. nov.

Plate V, Figs. 6, 8.

Shell elongate-ovate, white; nucleus hav- g a depressed helicoid spire with the axis t right angles to that of the following horls, in the first of which it is about one- hird immersed; normal whorls 7, upper horls slopingly shouldered, flat-sided, later horls slightly shouldered, slightly rounded; xial ribs strong, straight, vertical, 14 ap- earing on the first whorl, increasing to 20 n the last whorl; interspaces about twice s wide as the ribs, crossed by 4 spiral series f rectangular pits, the spaces between which ppear as flat-topped cords of unequal width, he lower 2 of these cords cut by 2 or 3 fine ncised spiral lines; periphery rounded, marked by a narrow spiral cord; base rounded, with a spiral row of pits just below he peripheral cord formed by the enfeebled xtensions of the axial ribs, below this there are 3 or 4 spiral cords and in the umbilical region several fine incised spiral lines; aper- ture ovate, outer lip thin, columella curved, slightly raised. The type measures: length, 3.1 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters), sandy mud, crushed shell.

The shell of this species differs from that of *Turbonilla* (*Pyrgisculus*) *eucosmia* Dall & Bartsch[93] in that the ribs are nearly vertical on all the whorls rather than strongly re- tractive on the last whorl.

This species is named for Pemasu Utu who collected numerous specimens during the ex- pedition on which the type of this species was collected.

Subgenus **Pyrgiscus** Philippi.

Turbonilla (Pyrgiscus) vivesi

Hertlein & Strong, sp. nov.

Plate VI, Fig. 15.

Shell elongate-conic, light yellowish-brown with a darker band covering the periphery and base and a narrow, fainter, dark band on the middle of the whorl; nuclear whorls moderately large, depressed, the axis at right angles to that of the postnuclear whorls, in the first of which it is about one-half immersed; postnuclear whorls 12, the greatest convexity falling a little below the middle; axial sculpture of rounded, nearly vertical ribs with wider interspaces; of these ribs 14 appear on the first whorl, gradually increasing to 22 on the last whorl; spiral sculpture of about 30 fine, closely spaced, incised lines in the interspaces between the axial ribs, of these the upper third are equal and equally spaced but on the middle of the whorls there is a tendency for them to become more irregular, and just above the suture there appears a row of deeper, rectangular pits; periphery with a narrow, smooth band, at the upper edge of which the axial ribs terminate; base short, rounded, with about 20 very fine, wavy spiral striations; aperture rhomboid, somewhat flaring at the anterior end; outer lip thin, showing the external sculpture within; columella straight, revolute. The type measures: length, 6.8 mm.; maximum diameter, 1.6 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Lower California, in the Gulf of California, dredged in 4-13 fathoms (7.5-24 meters), sand. 7 additional specimens were dredged at the same locality.

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *superba* Dall & Bartsch[94] in that it lacks the medial row of pits which are very distinct on that species.

This species is named for Gastón J. Vives of La Paz, Lower California, in recognition of his work on the culture of pearl oysters in the Gulf of California.

Turbonilla (Pyrgiscus) domingana

Hertlein & Strong, sp. nov.

Plate VI, Fig. 6.

Shell slender, regularly elongate-conic, translucent, white; nuclear whorls 2, depressed, with their axis at right angles to that of the postnuclear whorls in the first of which they are about one-third immersed; postnuclear whorls 10, the upper ones roundly shouldered, the last 2 flattened; axial sculpture of low, nearly vertical ribs, with wider interspaces, 14 appearing on the upper whorls and 16 on the last whorl; spiral sculpture of 9 incised lines in the interspaces between the axial ribs, the upper 4 widely spaced and occupying a little more than half the area between the sutures, the following 5 closely spaced with the last just above the suture, a little stronger than the others; periphery rounded, with a narrow smooth space bounded at the lower edge with an incised line at which the axial ribs terminate; base moderately long, with a second narrow, smooth space just below the peripheral one, followed by 5 closely spaced, incised spiral

[92] *Turbonilla* (*Ptycheulimella*) *magdalinensis* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 70, No. 2660, Art. 11, April 8, 1927, p. 4, pl. 1, fig. 7. "Magdalena Bay, Lower California." Cited on p. 34 as *Turbonilla* (*Ptycheulimela*) *magdalenensis*.

[93] *Turbonilla* (*Pyrgisculus*) *eucosmia* Dall & Bartsch, *U. S. Nat. Mus.*, *Bull.* 68, December 13, 1909, p. 128, pl. 12, figs. 13, 13a. "dredged at U. S. Bureau of Fisheries Station 2822, in 21 fathoms, off La Paz, Lower California."

[94] *Turbonilla* (*Pyrgiscus*) *superba* Dall & Bartsch, *U. S. Nat. Mus.*, *Bull.* 68, December 13, 1909, p. 80, pl. 7, figs. 10, 10a. "dredged at U. S. Bureau of Fisheries station 2822, in 21 fathoms, gray sand and broken shells, off La Paz, Lower California."

lines; aperture ovate, slightly expanded at the anterior end; outer lip thin, showing the external sculpture within; columella nearly straight, reflected, revolute; body with a slightly raised callus. The type measures: length, 6.3 mm.; maximum diameter, 1.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Lower California, in the Gulf of California, dredged in 4-13 fathoms (7.5-24 meters), sand.

The unique type can probably be best compared with *Turbonilla* (*Pyrgiscus*) *corsoensis* Bartsch[95] which has similar axial ribs and the same number of spiral lines. However, the present species possesses a more slender shell, with the later whorls less shouldered, and the arrangement of the spiral lines entirely different.

Turbonilla (Pyrgiscus) yolettae
Hertlein & Strong, sp. nov.
Plate VI, Fig. 13.

Shell small, elongate-conic, very slender, white; nuclear whorls 2½, large, depressed, the axis at right angles to that of the postnuclear whorls, in the first of which they are about one-fourth immersed; postnuclear whorls 9, the first 3 well rounded, the remainder less so, sutures distinct; axial sculpture of low, rounded, slightly waved, nearly vertical ribs, with somewhat wider, shallow interspaces, of these ribs 16 appear on the second whorl, gradually increasing to 22 on the last whorl; spiral sculpture of 10 incised lines in the interspaces between the axial ribs; of these the first 3 are very fine and closely spaced while the remainder are more distinct and rather irregular and irregularly spaced; periphery rounded, marked by a fine incised spiral line; base short, rounded, with a narrow smooth space just below the peripheral line marked by 6 very fine incised spiral lines and feeble continuations of the axial ribs; aperture ovate, defective in the type; columella short, strongly revolute, with a strong fold at its insertion; body with a distinct callus. The type measures: length, 4.1 mm.; maximum diameter, 1.1 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Lower California, dredged in 4-13 fathoms (7.5-24 meters), sand. A second specimen was dredged at the same locality.

This shell is much the size and shape of *Turbonilla* (*Pyrgiscus*) *histias* Dall & Bartsch[96] but has more feeble axial ribs and a different arrangement of the spiral cords.

Fresh specimens would probably show more or less of a color pattern.

Turbonilla (Pyrgiscus) amiriana
Hertlein & Strong, sp. nov.
Plate VI, Fig. 7.

Shell broadly conic, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls in the first of which it is about one-third immersed; normal whorls 8, broadly, slopingly shouldered; axial sculpture of low, rounded, somewhat sinuous ribs of which 18 appear on the first whorl, increasing to 24 on the last whorl; interspaces a little wider than the ribs, crossed by 5 spiral series of pits, of which the lower is just above the suture and the upper marks the beginning of the shoulder on which there are much finer incised spiral lines; periphery subangulated, marked by a wide spiral band without spiral sculpture but undulated by the ends of the axial ribs; base short, sculptured with about 10 irregularly spaced incised spiral lines; aperture subquadrate; outer lip defective, columella twisted. The type measures: length, 5.8 mm.; diameter, 2.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type. Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud.

The shell of this species differs from such species as *Turbonilla* (*Pyrgiscus*) *hypocurta* Dall & Bartsch[97] in the more broadly conic form.

Turbonilla (Pyrgiscus) colimana
Hertlein & Strong, sp. nov.
Plate VI, Fig. 5.

Shell elongate-conic, rather stout, very pale brown; nuclear whorls having a depressed helicoid spire, with the axis at right angles to that of the following whorls in the first of which it is about one-third immersed; normal whorls 7, slightly rounded with a well rounded shoulder and somewhat contracted at the suture; axial ribs strong, rounded, nearly vertical, slightly swollen at the shoulder angle, 14 appearing on the first whorl and increasing to 18 on the last whorl; interspaces about twice as wide as the ribs, crossed by 5 equal and equally spaced spiral series of deeply incised lines below the shoulder and 2 or 3 finer lines on the shoulder; periphery rounded, marked by a smooth band a little wider than the spaces between the incised spiral lines, on which the axial ribs terminate; base short, rounded, with 5 incised spiral lines similar to those on the spire but continuous; aperture subquadrate,

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[95] *Turbonilla* (*Pyrgiscus*) *corsoensis* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 52, No. 2193, May 29, 1917, p. 657, pl. 45, fig 8. "dredged in shallow water in Santa Maria Bay, Lower California."

[96] *Turbonilla* (*Pyrgiscus*) *histias* Dall & Bartsch, *U. S. Nat. Mus.*, *Bull.* 68, December 13, 1909, p. 105, pl. 10, figs. 8, 8a. "Off La Paz, in 21 fathoms, on sand bottom off Lower California."

[97] *Chemnitzia hypocurta* Dall & Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 30, No. 1452, May 9, 1906, p. 347. New name for *Chemnitzia caelata* Carpenter (*Ann. & Mag. Nat. Hist.*, Ser. 3, Vol. 15, May, 1865, p. 400. "probably from Panama"). Not *Turbonilla caelata* Gould, 1861. Carpenter's species was also renamed *Turbonilla* (*Pyrgiscus*) *favilla* by Dall & Bartsch (*U. S. Nat. Mus.*, *Bull.* 68, December 13, 1909, p. 78).

ter lip thin, columella short, curved. The pe measures: length, 3.0 mm.; diameter, 9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. ype Coll.), from Station 184-D-2, Lat. ° 04′ 00″ N., Long. 104° 22′ 00″ W., near anzanillo, Mexico, dredged in 30 fathoms 55 meters), gravelly sand.

Although the type specimen is not fully ature it should be easily recognizable by e shape and sculpture.

The shell of this species bears a resem-lance to that of *Turbonilla* (*Pyrgiscus*) *ypocurta* Dall & Bartsch[98] and similar orms but differs chiefly in that the whorls re roundly shouldered rather than flattened.

Turbonilla (Pyrgiscus) zacae
Hertlein & Strong, sp. nov.
Plate III, Fig. 3.

Shell elongate-conic, slender, white; nu-leus having a depressed helicoid spire with he axis at right angles to that of the fol-owing whorls, in the first of which it is bout one-third immersed; normal whorls 0, flat sided; axial ribs narrow, straight, early vertical, 16 appearing on the first horl, increasing to 20 on the last whorl; nterspaces about twice as wide as the ribs, rossed by 10 spiral series of subequal in-ised spiral lines; periphery well rounded, narked by a rather wide band without piral sculpture but rendered slightly no-lulous by the lower ends of the axial ribs; ase short, rounded, with 6 incised spiral ines; aperture subquadrate, outer lip roken, columella straight, high, leaving a light umbilical chink. The type measures: ength, 5.7 mm.; diameter, 1.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fath-oms (22 meters), shelly mud.

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *melea* Bartsch[99] in that it is sculptured with 20 ribs on the ast whorl rather than 28.

Turbonilla (Pyrgiscus) sulacana
Hertlein & Strong, sp. nov.
Plate VI, Fig. 12.

Shell elongate-conic, white; nucleus hav-ing a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 9, well rounded, upper whorls roundly shouldered, later ones less so; axial ribs low, rounded, sinuous, nearly vertical, of which 14 appear on the first whorl, increasing to 20 on the last whorl; interspaces about twice as wide as the ribs, crossed by 6 spiral series of pits varying somewhat in strength and spacing and between these a varying number of very fine spiral lines; periphery rounded, marked by a narrow band without spiral sculpture but rendered somewhat nodulous by the ends of the axial ribs; base short, rounded, marked with 6 incised spiral lines, the up-per one or two interrupted in some places by the feeble extension of an axial rib; aper-ture subquadrate, outer lip thin, columella nearly straight with a raised edge. The type measures: length, 5.0 mm.; diameter 1.1 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fath-oms (22 meters), shelly mud.

The shell of this species may be differen-tiated from that of *Turbonilla* (*Pyrgiscus*) *pequensis* Dall & Bartsch[100] in that the whorls are only moderately roundly shoul-dered rather than strongly so.

Turbonilla (Pyrgiscus) templetonis
Hertlein & Strong, sp. nov.
Plate VI, Fig. 11.

Shell elongate-conic, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 9, well rounded; axial ribs strong, rounded, nearly vertical, distinctly sinuous, flattening out toward the summit, giving the whorls a slopingly shoul-dered appearance, of these ribs 16 appear on the first whorl, increasing to 20 on the last whorl; interspaces about 3 times as wide as the ribs, crossed by 6 spiral series of pits of which the basal 1 or 2 are slightly the stronger, and on the raised areas between the pits a few scattered, very fine incised spiral lines; periphery subangulated, marked by a band without spiral sculpture but un-dulated by the axial ribs; base short, with 6 narrow incised spiral lines of which the upper 2 or 3 cut across the feeble extensions of the axial ribs; aperture subquadrate, outer lip thin, columella straight. The type measures: length 4.3 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-1, Lat 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters), sandy mud, crushed shell.

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *angusta* Car-penter[101] in that the base is short rather than somewhat extended, also in that the periph-ery of the last whorl is subangulated rather than rounded.

This species is named for the late Temple-ton Crocker.

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98 For references to this species see footnote No. 97 on p. 94.

99 *Turbonilla* (*Pyrgiscus*) *melea* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 66, No. 2551, Art. 14, October 17, 1924, p. 5, pl. 2, fig. 8. From "Santa Elena Bay, Ecuador."

100 *Turbonilla* (*Pyrgiscus*) *pequensis* Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, December 13, 1909, p. 79, pl. 7, figs. 5, 5a. "U. S. Bureau of Fisheries station 2834, near Point Abreojos, in 12 fathoms, on sand bottom, off Lower California."

101 *Chrysallida angusta* Carpenter, *Ann. & Mag. Nat. Hist.*, Ser. 3, Vol. 14, July, 1864, p. 47. "Cape St. Lucas."—Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, 1909, p. 91, pl. 8, fig. 6 (as *Turbonilla* (*Pyrgiscus*) *angusta*).

Turbonilla (Pyrgiscus) ayamana
Hertlein & Strong, sp. nov.
Plate VI, Fig. 14.

Shell elongate-conic, slender, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 9, slightly rounded, narrowly slopingly shouldered; axial ribs strong, in general vertical but varying somewhat in angle from whorl to whorl, of these ribs 18 appear on the first whorl, increasing to 24 on the last whorl; interspaces about twice as wide as the ribs, crossed on the upper whorls by 7 spiral series of pits, on the last whorl the lower 2 of these become very strong while numerous finer spiral incised lines tend to break up the areas between the major pits; periphery well rounded, marked by a narrow smooth band; base short with 2 rows of spiral pits similar to those on the spire immediately below the periphery between the feeble extensions of the axial ribs, lower part of the base with 4 continuous incised spiral lines; aperture subquadrate, outer lip thin, columella somewhat twisted. The type measures: length, 5.6 mm.; diameter, 1.3 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters), sandy mud, crushed shell. Additional specimens were dredged at Port Parker, Costa Rica, (203-D-3), 12 fathoms (22 meters), shelly mud, and at Corinto, Nicaragua (200-D-19), 12-13 fathoms (22-24 meters), mangrove leaves.

The very slender form of the shell of this species serves to differentiate it from *Turbonilla* (*Pyrgiscus*) *macra* Dall & Bartsch[102].

Turbonilla (Pyrgiscus) otnirocensis
Hertlein & Strong, sp. nov.
Plate V, Fig. 4.

Shell elongate-conic, slender, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 9, rather high between the sutures, narrowly, roundly shouldered, flat-sided; axial ribs low, rounded, nearly straight, somewhat retractive, 16 appearing on the first whorl, increasing to 24 on the last whorl; interspaces about twice as wide as the ribs, crossed by 12 fine, incised spiral lines, about equal in strength but unequal in spacing; periphery well rounded, without definite marking; base somewhat produced, rounded, the upper part with 3 spiral series of incised lines in the interspaces between the feeble extensions of the axial ribs, the lower part with 3 continuous incised spiral lines; aperture ovate, outer lip very thin, columella slightly curved. The type measures: length, 4.2 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station, 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves. Additional specimens were secured in the beach drift at Corinto.

The shell of this species may be differentiated from that of *Turbonilla* (*Pyrgiscus*) *collea* Bartsch[103] in that the incised lines between the sutures number 12 rather than 6.

Turbonilla (Pyrgiscus) ulyssi
Hertlein & Strong, sp. nov.
Plate 5, Fig. 10.

Shell elongate-conic, rather stout, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 8, the upper whorls well rounded, the later whorls less so; axial ribs low, rounded, distinctly protractive on the upper whorls, nearly vertical on the later ones, 18 appearing on the first whorl, increasing to 28 on the last whorl, the ribs are contracted to sharp points at the summit, undulating the suture; interspaces only a little wider than the ribs, crossed by sharp, incised spiral lines, varying somewhat in number and spacing from whorl to whorl but averaging about 15; periphery rounded, without definite marking; base produced, with about 15 incised spiral lines similar in strength and spacing to those on the spire, the upper 5 or 6 interrupted by feeble extensions of the axial ribs; aperture ovate, outer lip slightly thickened, columella short, straight. The type measures: length, 5.0 mm.; diameter, 1.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves. Additional specimens were secured in the beach drift at Corinto.

The character of the axial ribbing of this species, sharply pointed at the ends of the ribs, serves to differentiate it from such species as *Turbonilla* (*Pyrgiscus*) *flavescens* Carpenter[104].

This species is named for Dr. Ulysses S. Grant, IV, Professor of Paleontology, University of California at Los Angeles.

Turbonilla (Pyrgiscus) nicoyana
Hertlein & Strong, sp. nov.
Plate III, Fig. 4.

Shell elongate-conic, slender, white, with

[102] *Turbonilla* (*Pyrgiscus*) *macra* Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, December 13, 1909, p. 91, pl. 8, figs. 10, 10a. "Point Abreojos, Lower California."

[103] *Turbonilla* (*Pyrgiscus*) *collea* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 69, No. 2646, Art. 20, December 16, 1926, p. 8, pl. 1, fig. 4. "coast southeast of Punta Santa Elena, Santa Elena Peninsula, Ecuador."

[104] *Chemnitzia flavescens* Carpenter, Cat. Mazatlan Shells, December, 1856, p. 432. "Hab.—Mazatlan; 1 sp. off Spondylus calcifer; Havre Col."—Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, 1909, p. 89, pl. 8, fig. 9 (as *Turbonilla* (*Pyrgiscus*) *flavescens*).

aint indications of brown on some whorls; ucleus having a depressed helicoid spire vith the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 7, the first 3 strongly, almost tabulately shouldered, the later whorls becoming shouldered; axial ribs straight, nearly vertical, rounded, flattening out on the shoulder, 16 appearing on the first whorl, increasing to 22 on the last; interspaces a little wider than the ribs, crossed by 12 incised spiral lines which extend up on the sides of the ribs but do not cross them, of these spiral lines there is on some whorls a tendency for the basal one and one a little above the middle of the whorls to become stronger; periphery rounded, marked by a narrow undulated band; base somewhat produced, marked with 5 incised spiral lines which cross over the feeble extensions of the axial ribs; aperture oval, outer lip thin, columella twisted. The type measures: length, 4.0 mm.; diameter, 1.1 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud. Additional specimens were dredged near Port Parker, Costa Rica (203-D-1), 15 fathoms (27 meters), sandy mud, crushed shell.

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *wetmorei* Strong & Hertlein[105] and similar forms in the much shorter and more rounded base.

This species is named for the Sixteenth Century Indian Chief Nicoya of Costa Rica.

Turbonilla (Pyrgiscus) cholutecana Hertlein & Strong, sp. nov.

Plate V, Fig. 5.

Shell very slender, upper whorls translucent, white, the later whorls becoming pale brown, very thin, the basal portion of each whorl shining through the upper portion of the following whorl; nucleus large, having a depressed helicoid spire with the axis at right angles to that of the following whorl, in the first of which it is about one-fourth immersed; normal whorls 8, almost flat-sided, little raised above the sutures; axial ribs low, straight, vertical, 20 appearing on the first whorl, increasing to 26 on the last whorl; interspaces about as wide as the ribs, crossed by about 16 very fine, spiral series of incised lines of about equal strength and spacing; periphery rounded, marked by a wide space without spiral sculpture; base decidedly produced, the upper part with three incised spiral lines which are broken by the feeble extensions of the axial ribs, the lower part with 3 continuous incised spiral lines; aperture ovate, outer lip very thin, columella curved. The type measures: length 4.1 mm.; diameter, 0.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua.

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *lazaroensis* Bartsch[106] in that the axial ribs are low and flattened rather than strong and rounded.

The specific name of this species is derived from the tribal name of the Cholutec Indians, Nicaragua.

Turbonilla (Pyrgiscus) chinandegana Hertlein & Strong, sp. nov.

Plate V, Fig. 3.

Shell elongate-conic, milk-white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls in the first of which it is about one-fourth immersed; normal whorls 9, almost flat-sided, moderately elevated above the sutures; axial ribs rounded, straight, retractive; interspaces a little wider than the ribs, crossed by about 15 equal and equally spaced spiral series of incised lines; periphery well rounded, marked by a wide smooth space; base moderately produced, the upper part with 1 or 2 incised spiral lines which are interrupted by the feeble extensions of the axial ribs, followed by a second wide smooth space, lower part of the base with 5 closely spaced continuous incised spiral lines; aperture ovate, outer lip thin, columella twisted. The type measures: length, 4.8 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua.

The more broadly conic form of this species serves to separate it from similar species such as *T. lazaroensis* Bartsch and *T. cholutecana* in which the shells are exceedingly slender.

The specific name of this species is derived from the name of the state of Chinandega, Nicaragua.

Turbonilla (Pyrgiscus) guanacastensis Hertlein & Strong, sp. nov.

Plate V, Fig. 11.

Shell elongate-conic, slender, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is only slightly immersed; normal whorls 10, moderately rounded, the first 3 increasing very little in size, later ones more rapidly; axial ribs low, rounded, nearly straight, moderately retractive, 18 appearing on the first whorl, increasing to 24 on the last whorl; interspaces a little wider than the ribs, crossed by a basal spiral series of deep pits and 10 unequal and unequally spaced shallower pits or incised lines; periphery round-

105 *Turbonilla* (*Pyrgiscus*) *wetmorei* Strong & Hertlein, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 22, No. 6, December 31, 1937, p. 172, pl. 35, fig. 1. "Lat. 23° 12′ N., Long. 106° 29′ W., dredged in 12 fathoms, about five miles west of Mazatlan, Sinaloa, Mexico."

106 *Turbonilla* (*Pyrgiscus*) *lazaroensis* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 52, No. 2193, May 29, 1917, p. 655, pl. 45, fig. 11. "dredged in shallow water off Lazaro Point, Santa Maria Bay, Lower California."

ed, marked by a narrow smooth band, base produced, aperture broken. The type measures: length, 4.3 mm.; diameter, 0.9 mm. A smaller paratype shows the aperture to be ovate and the base marked with 6 incised spiral lines of which the first 2 are interrupted by the feeble extensions of the axial ribs.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud. An additional specimen was dredged near Port Parker, Costa Rica (203-D-1), 15 fathoms (27 meters), sandy mud, crushed shell.

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *bartonella* Strong & Hertlein[107] in that the axial ribs are protractive rather than nearly vertical.

The specific name of this species is derived from the name of the state of Guanacaste, Costa Rica.

Turbonilla (Pyrgiscus) ozanneana
Hertlein & Strong, sp. nov.
Plate V, Fig. 15.

Shell elongate-conic, slender, white; nucleus broken; normal whorls 9, slightly rounded, narrowly shouldered at the summit and contracted at the base; axial ribs low, rounded, nearly straight, vertical on the upper whorls, somewhat retractive on the last whorl, 16 appearing on the first whorl, increasing to 22 on the last whorl; interspaces about twice as wide as the ribs, crossed by a basal spiral series of pits and 9 incised lines of about equal strength and spacing; periphery well rounded, marked by a rather broad, smooth band; base short, with 6 incised spiral lines, the first 2 being interrupted by the enfeebled extensions of the axial ribs; aperture subquadrate, outer lip thin, columella nearly straight, with a slight fold at its insertion. The type measures: length, 3.9 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua.

The shell of this species may be differentiated from that of *Turbonilla* (*Pyrgiscus*) *domingana* in that the axial ribs are somewhat retractive rather than vertical.

This species is named for Mr. John Ozanne, First Mate on the *Zaca* during the expedition on which the type specimen of this species was collected.

Turbonilla (Pyrgiscus) rhizophorae
Hertlein & Strong, sp. nov.
Plate V, Fig. 12.

Shell elongate-conic, translucent, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 8, rounded, upper whorls narrowly shouldered, the first 3 rapidly increasing in size; axial ribs strong, rounded, distinctly protractive, sinuous, 12 appearing on the first whorl, increasing to 18 on the last whorl; interspaces about 3 times as wide as the ribs, terminating abruptly at the periphery, crossed by a basal spiral series of pits and about 24 fine incised spiral lines; periphery well rounded, without definite marking; base rounded, marked with numerous fine spiral striations which on the upper part ride over low swellings formed by the feeble extensions of the axial ribs; outer lip broken, columella straight. The type measures: length, 3.4 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

This is one of the species which show intergradation between the subgenera *Strioturbonilla* and *Pyrgiscus.*

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *biolleyi* in that there are 18 rather than 24 axial ribs on the last whorl.

Turbonilla (Pyrgiscus) biolleyi
Hertlein & Strong, sp. nov.
Plate III, Fig. 2.

Shell regularly elongate-conic, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 8, slightly rounded, upper whorls slopingly shouldered; axial ribs sharp, sinuous, moderately protractive, 16 appearing on the first whorl, increasing to 24 on the last whorl; interspaces about twice as wide as the ribs, crossed by a basal spiral series of pits and about 25 incised spiral lines of which every third or fourth appears slightly the stronger; periphery subangulated, marked by a narrow band without spiral sculpture but undulated by the axial ribs; base short, with incised spiral lines similar to those on the spire, which on the upper part ride over the feeble extensions of the axial ribs; aperture subquadrate, outer lip broken, columella straight. The type measures: length, 3.6 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud. Specimens were also dredged near Port Parker, Costa Rica (203-D-1), 15 fathoms (27 meters), sandy mud, crushed shell, and at Corinto, Nicaragua (200-D-19), 12-13 fathoms (22-24 meters), mangrove leaves, and in the beach drift at Corinto.

The shell of this species differs from that of *Turbonilla* (*Pyrgiscus*) *rhizophorae* in

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[107] *Turbonilla* (*Pyrgiscus*) *bartonella* Strong & Hertlein, Allan Hancock Pac. Exped., Vol. 2, No. 12, August 21, 1939, p. 203, pl. 19, fig. 8. "dredged in from 3 to 9 fms. in Bahia Honda, Panama."

hat there are 24 rather than 18 axial ribs n the last whorl.

This species is named for Paul Biolley, ormer professor of Natural History at San ose de Costa Rica.

Turbonilla (Pyrgiscus) ekidana
Hertlein & Strong, sp. nov.
Plate IV, Fig. 8.

Shell elongate-conic, milk-white; nucleus small, with a depressed helicoid spire having the axis at right angles to that of the following whorls, in the first of which it is about one-half immersed; normal whorls 9, broadly slopingly shouldered, somewhat flattened below the shoulder; axial ribs strong, rounded, sinuous, vertical on the upper whorls, becoming slightly retractive on the last, 14 appearing on the first whorl, increasing to 20 on the last whorl; interspaces about twice as wide as the ribs, crossed by a basal series of pits and a second series just below the angle of the shoulder, in addition there are 7 spiral series of incised lines between the 2 series of pits and 6 series of much finer incised lines on the shoulder; periphery rounded, marked by a narrow band without spiral sculpture; base short, with 7 incised spiral lines of which the second below the periphery is the strongest and the first 3 more or less interrupted by the feeble extensions of the axial ribs; aperture subquadrate, outer lip slightly thickened, columella curved, a little expanded over the umbilical region. The type measures: length, 4.8 mm.; diameter, 1.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters), sandy mud, crushed shell.

The shell of this species bears a resemblance to that of *Turbonilla* (*Pyrgiscus*) *callipeplum* Dall & Bartsch[108] and similar forms but differs in that the axial ribs are rounded, not sublamellar.

Turbonilla (Pyrgiscus) gordoniana
Hertlein & Strong, sp. nov.
Plate V, Fig. 1.

Shell regularly elongate-conic, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 11, slightly rounded, little elevated above the sutures; axial ribs low, rounded, straight, nearly vertical, 16 appearing on the first whorl, increasing to 24 on the last whorl; interspaces about as wide as the ribs, crossed by 10 equal and equally spaced spiral series of incised lines; periphery rounded, without definite marking; base rather short, rounded, the axial ribs extending to the umbilical region with, in the interspaces, series of incised spiral lines similar to those on the spire; aperture oval, outer lip thin, columella raised, curved, somewhat expanded over the umbilical region. The type measures: length, 6.0 mm.; diameter, 1.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua.

The character of the upper whorls, slightly rounded rather than narrowly shouldered, serves to separate this species from *Turbonilla* (*Pyrgiscus*) *craticulata* Mörch[109].

This species is named for Mackenzie Gordon, Jr., of Palo Alto, California.

Turbonilla (Pyrgiscus) ottomoerchi
Hertlein & Strong, sp. nov.
Plate IV, Fig. 5.

Shell elongate-conic, slender, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 10, flat-sided, narrowly, slopingly shouldered on the upper whorls, little raised above the sutures on the later whorls; axial ribs low, moderately retractive, straight, extending to the umbilical region, 16 appearing on the first whorl, increasing to 26 on the last; interspaces about as wide as the ribs, crossed by 12 equal and equally spaced spiral series of incised lines; periphery rounded, without definite marking; base rounded, marked with incised spiral lines similar to those on the spire except that on the lower part they ride over the low swellings which mark the extensions of the axial ribs in the umbilical region; aperture oval, outer lip thin, columella somewhat twisted. The type measures: length, 6.0 mm.; diameter, 1.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua. Specimens were also secured at Corinto (200-D-19), 12-13 fathoms (22-24 meters), mangrove leaves.

The shell of this species may be differentiated from that of *Turbonilla* (*Pyrgiscus*) *porteri* Baker, Hanna & Strong[110] in that the upper whorls are narrowly slopingly shouldered rather than well rounded.

This species is named for Otto A. L. Mörch, author of a paper describing the mollusks collected by A. S. Oersted along the west coast of Central America.

Turbonilla (Pyrgiscus) tehuantepecana
Hertlein & Strong, sp. nov.
Plate V, Fig. 7.

Shell subcylindrical, pale brown, very small; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, much smaller than the

108 *Turbonilla* (*Pyrgiscus*) *callipeplum* Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, December 13, 1909, p. 96, pl. 9, figs. 11, 11a. "dredged at U. S. Bureau of Fisheries station 2805 in 51 fathoms, on mud bottom, in Panama Bay."

109 *Turbonilla craticulata* Mörch, *Malakozool. Blätter*, Bd. 6, p. 119, October, 1859. "Hab. Bocorones, 30 org. prof. Specimina 3."—Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, 1909, p. 104, pl. 10, figs. 1, 1a.

110 *Turbonilla* (*Pyrgiscus*) *porteri* Baker, Hanna & Strong, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 17, No. 7, June 29, 1928, p. 217, pl. 11, fig. 10. "Gulf of California."

first in which it is about one-half immersed; normal whorls 7, slightly rounded, narrowly shouldered; axial ribs sharp, straight, nearly vertical, of which 16 appear on the first whorl, increasing to 26 on the last whorl; interspaces a little wider than the ribs, crossed by 4 spiral series of rectangular pits of which the uppermost corresponds to a depression in the axial ribs, thus forming a narrow, nodulous band just below the sutures, the raised spaces between the pits with very fine incised spiral lines; periphery well rounded, without definite marking; base rather short, with 6 series of spiral pits in the interspaces between the axial ribs which extend to the umbilical region; aperture ovate, outer lip slightly thickened, columella curved. The type measures: length, 2.8 mm.; diameter, 0.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The shell of this species is somewhat similar to that of *Turbonilla* (*Pyrgiscus*) *indentata* Carpenter[111] but may be differentiated from that form in that the whorls are narrowly rather than subtabulately shouldered.

Turbonilla (Pyrgiscus) gruberi
Hertlein & Strong, sp. nov.

Plate IV, Fig. 3.

Shell elongate-conic, slender, pale, brownish; nucleus large, having a depressed helicoid spire with the axis at right angles to the following whorls, on the first of which it rests; normal whorls 9, the first 2 smooth, the others sculptured, slightly rounded, little raised above the sutures; axial ribs low, straight, strongly retractive, 24 appearing on the third whorl, increasing to about 40 on the last whorl; interspaces a little wider than the ribs, crossed by 7 spiral series of pits and incised lines unequal in strength and spacing; periphery rounded, marked by a narrow, smooth band; base well rounded with the axial ribs continuing over the umbilical region, the interspaces crossed by spiral series of pits and incised lines similar to those on the spire; aperture oval, outer lip slightly thickened, columella curved. The type measures: length, 6.1 mm.; diameter, 1.4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua. Additional specimens were secured at Corinto, Nicaragua (200-D-19), 12-13 fathoms (22-24 meters), mangrove leaves.

The shell of this species differs from such species as *Turbonilla* (*Pyrgiscus*) *larunda* Dall & Bartsch and *Turbonilla* (*Pyrgiscus*) *cortezi* Bartsch in that there are about 40 rather than 20 or 30 axial ribs on the last whorl.

This species is named for Ferdinand Gruber, a former Curator of Ornithology and Mammalogy, California Academy of Sciences. He was the inventor of the zoographican installed at Woodward's Gardens of which organization he was Curator of Museums, and later was Director of Natural History at M. H. De Young Memorial Museum, San Francisco, California.

Subgenus **Pyrgolampros** Sacco.

Turbonilla (Pyrgolampros) soniliana
Hertlein & Strong, sp. nov.

Plate IV, Fig. 2.

Shell elongate-conic, pale brown with a dark brown line a little above the suture and a second similar line on the middle of the base; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 9, slightly rounded, little raised above the sutures; axial ribs low, nearly vertical on the upper whorls, increasingly retractive on the middle whorls, curved and strongly retractive on the last whorl, 18 appearing on the first whorl, increasing to 30 on the last whorl; interspaces somewhat wider than the ribs, crossed by basal and median spiral lines of shallow pits and many fine spiral striations; periphery somewhat inflated, rounded, without definite marking; base rounded, the axial ribs fading out at the brown basal line, lower half with numerous continuous spiral striations; aperture ovate, outer lip thin, showing the two brown lines within, columella narrow, slightly curved and somewhat raised. The type measures: length, 5.8 mm.; diameter, 1.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The shell of this species differs from that of *Turbonilla* (*Pyrgolampros*) *mangueren-sis* in that the axial ribs are retractive rather than protractive.

Turbonilla (Pyrgolampros) meanguerensis
Hertlein & Strong, sp. nov.

Plate IV, Fig. 6.

Shell elongate-conic, uniformly pale brownish; nucleus having an elevated spire with the axis at right angles to that of the following whorls, the tip extending a little beyond and notching the edge of the first, in which it is nearly one-half immersed; normal whorls well rounded; axial ribs low, rounded, straight, almost vertical, 18 appearing on all whorls; interspaces about as wide as the ribs on the upper whorls, the width increasing to about 4 times as wide as the ribs on the last whorl, crossed by peripheral lines of pits and many fine spiral striations, of which 3 or 4 are distinctly the stronger

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[111] *Chrysallida indentata* Carpenter, Cat. Mazatlan Shells, December, 1856, p. 425. "Hab.—Mazatlan; 2 sp. off Spondylus; L'pool Col."—Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, 1909, p. 102, pl. 10, fig. 10 (as *Turbonilla* (*Pyrgiscus*) *indentata*).

some of the whorls; periphery subangu-ed, base short, the axial ribs terminating st below the periphery, with numerous avy incised spiral lines; aperture subquad-te, outer lip thin, columella straight. The pe measures: length 5.6 mm.; diameter, 4 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. ype Coll.), from Station 199-D-1, Lat 13° 3′ 00″ N., Long. 87° 43′ 00″ W., Meanguera land, Gulf of Fonseca, El Salvador, edged in 16 fathoms (29 meters), sand, ud, crushed shell.

The shell of this species can be differen-ated from that of *Turbonilla* (*Pyrgolam-ros*) *soniliana* in that the axial ribs are rotractive rather than retractive.

Subgenus **Strioturbonilla** Sacco.

Turbonilla (Strioturbonilla) masayana
Hertlein & Strong, sp. nov.
Plate IV, Fig. 4.

Shell elongate-conic, translucent, white; ucleus having an elevated spire, with the xis at right angles to that of the following horls, the tip extending beyond and notch-ng the edge of the first whorl in which it s nearly one-half immersed; normal whorls , nearly flat-sided, narrowly squarely shoul-ered; the entire surface with very fine piral striations; axial ribs low, narrow, al-nost vertical, 24 appearing on the first vhorl, increasing to 30 on the last whorl; nterspaces a little wider than the ribs, ter-ninating a little above the periphery, leav-ng a narrow smooth band in the suture; eriphery well rounded, base rounded; aper-ure subquadrate, outer lip thin, columella omewhat twisted. The type measures: ength, 3.4 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Col.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

The shell of this species differs from that of *Turbonilla* (*Strioturbonilla*) *santamari-ana* Bartsch[112] in that the axial ribs on the ast whorl number 30 rather than 20.

The specific name of this species is de-rived from that of the tribal name of the Masaya Indians of Nicaragua.

Turbonilla (Strioturbonilla) corintonis
Hertlein & Strong, sp. nov.
Plate IV, Fig. I.

Shell elongate-conic, white; nucleus hav-ing an elevated spire, with the axis at right angles to that of the following whorls, the tip extending a little beyond and notching the edge of the first whorl in which it is about one-half immersed; normal whorls 10, slightly rounded, very narrowly shouldered; entire surface with very fine spiral stria-tions; axial ribs low, rounded, nearly straight, somewhat protractive, 18 appear-ing on the first whorl, increasing to 25 on the last whorl; interspaces a little wider than the ribs, terminating a little above the periphery, leaving a narrow, smooth band in the suture; periphery rounded, base short, well rounded; aperture subquadrate, outer lip thin, columella somewhat reflected over the umbilical area. The type measures: length, 5.2 mm.; diameter, 1.3 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua.

The shell of this species may be differen-tiated from that of *Turbonilla* (*Strioturbonilla*) *oaxacana* in that the base is short and rounded rather than decidedly extended.

Turbonilla (Strioturbonilla) oaxacana
Hertlein & Strong, sp. nov.
Plate V, Fig. 9.

Shell elongate-conic, rather stout, trans-lucent, white; nucleus very small, having an elevated spire with the axis at right angles to that of the following whorls in the first of which it is about one-fourth immersed; normal whorls 8, strongly rounded, almost tabulately shouldered; entire surface with very fine spiral striations; axial ribs rounded, nearly straight, protractive, 14 appearing on the first whorl, increasing to 24 on the last whorl; interspaces about twice as wide as the ribs, terminating a little above the periphery, leaving a narrow smooth band in the sutures; periphery rounded, base de-cidedly produced; aperture ovate, outer lip thin, columella straight. The type measures: length, 3.5 mm.; diameter, 1.1 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

This species differs from *Turbonilla* (*Strioturbonilla*) *corintonis* in that the base of the shell is decidedly produced rather than short and rounded.

Turbonilla (Strioturbonilla) nahuatliana
Hertlein & Strong, sp. nov.
Plate V, Fig. 14.

Shell small, elongate-conic, translucent, white; nucleus having an elevated spire with the axis at right angles to that of the fol-lowing whorls, the tip extending beyond the edge of the first whorl in which it is slight-ly immersed; normal whorls 9, well rounded, entire surface with very fine spiral striae; axial ribs strong, rounded, nearly straight, decidedly protractive, 14 appearing on the first whorl, increasing to 20 on the last whorl; interspaces well impressed, a little wider than the ribs, extending from suture to suture and terminating at the periphery; periphery rounded, base short, well rounded; aperture subquadrate, outer lip thin, colu-mella straight. The type measures: length, 2.8 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo.

112 *Turbonilla* (*Strioturbonilla*) *santamariana* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 52, No. 2193, May 29, 1917, p. 642, pl. 44, fig. 2. "dredged in shallow water in Santa Maria Bay, Lower California."

Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

The shell of this species may be differentiated from that of *Turbonilla* (*Strioturbonilla*) *mcguirei* Strong & Hertlein[113] in that the axial ribs are decidedly protractive rather than only moderately so.

The specific name of this species is derived from the tribal name of the Nahuatl Indians of Central America.

Turbonilla (Strioturbonilla) contrerasiana
Hertlein & Strong, sp. nov.
Plate V, Fig. 13.

Shell elongate-conic, white; nucleus having an elevated spire, with the axis at right angles to that of the following whorls, the tip extending beyond the edge of the first whorl, in which it is about one-fourth immersed; normal whorls 9, very narrowly shouldered, well rounded, entire surface with very fine, microscopic spiral striations; axial ribs strong, nearly straight, decidedly protractive, 14 appearing on the first whorl, increasing to 20 on the last whorl; interspaces about twice as wide as the ribs, extending from suture to suture and terminating at the periphery which is rounded and without band or other marking; base short, rounded, with feeble extensions of the axial ribs on the upper part, and microscopic spiral striae similar to that on the spire; aperture subquadrate, outer lip thin, columella short, straight. The type measures: length, 3.4 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The shell of this species may be differentiated from that of *Turbonilla* (*Strioturbonilla*) *nahuana* Baker, Hanna & Strong[114] in that the axial ribs are nearly straight rather than sinuous.

This species is named for Professor Francisco Contreras of the National Museum of Natural History of Mexico.

Turbonilla (Strioturbonilla) nicaraguana
Hertlein & Strong, sp. nov.
Plate IV, Fig. 7.

Shell elongate-conic, white; nucleus with a depressed helicoid spire having the axis at right angles to that of the following whorls, in the first of which it is about one-third immersed; normal whorls 9, moderately rounded, very narrowly shouldered at the summit, somewhat overhanging at the base; axial ribs low, rounded, sinuous, moderately protractive, 18 appearing on the first whorl, increasing to 26 on the last whorl; interspaces a little wider than the ribs, cross by a narrow peripheral line of pits and abo 30 fine, incised spiral lines; periphery w rounded, marked by a narrow band withc spiral sculpture but undulated by the en of the axial ribs and with a few incised ax lines in the interspaces; base short, rounde with about 12 incised spiral lines which c across the feeble extensions of the axial rib aperture subquadrate, outer lip thin, col mella straight. The type measures: lengt 4.5 mm.; diameter, 1.2 mm.

Holotype (Calif. Acad. Sci. Dept. Pale Type Coll.), from Station 200-D-19, Lat. 1 28′ 03″ N., Long. 87° 12′ 39″ W., near Corint Nicaragua. dredged 12-13 fathoms (22- meters), mangrove leaves.

The shell of this species differs from th of *Turbonilla* (*Strioturbonilla*) *affinis* C. Adams[115] in that the axial ribs are sinuo rather than straight.

This species is named for the India Chief Nicaragua.

Genus **Odostomia** Fleming.
Subgenus **Besla** Dall & Bartsch.
Odostomia (Besla) caneloensis
Hertlein & Strong, sp. nov.
Plate VII, Fig. 3.

Shell minute, slender, elongate-conic, n cleus large, having a slightly elevated spir with the axis at nearly a right angle to th of the following whorls, in the first of whic it is about one-third immersed; norm whorls 5, strongly angulated at the posteri extremity of the anterior third; axial ri strong, sinuous, somewhat protractive, 1 appearing on the first whorl, increasing to 1 on the last whorl; spiral sculpture in 2 serie on the upper two-thirds of the whorls the appear 3 fine incised lines in the interspac between the ribs, followed by a strong co at the angle, a second cord, equally stron just above the sutures and a third simil cord half way between the two, formin spiral series of rectangular pits in the inte spaces; periphery rounded, marked by spiral cord similar to the preceding 3; bas rounded, marked with the enfeebled exte sions of the axial ribs and finer spiral cord aperture ovate, outer lip thin, columell slender, curved, with a slender fold at its in sertion. The type measures: length 1.6 mm. diameter, 0.5 mm.

Holotype (Calif. Acad. Sci. Dept. Pale Type Coll.), from Station 203-D-1, Lat. 10 56′ 05″ N., Long. 85° 49′ 25″ W., near Po Parker, Costa Rica, dredged in 15 fathom (27 meters), sandy mud, crushed shell.

The shell of this species differs from tha of *Odostomia* (*Besla*) *convexa* Carpenter[11

[113] *Turbonilla* (*Strioturbonilla*) *mcguirei* Strong & Hertlein, Allan Hancock Pac. Exped., Vol. 2, No. 12, August 21, 1939, p. 197, pl. 19, fig. 1. "dredged in from 3 to 9 fms. off Taboga Island, Panama."

[114] *Turbonilla* (*Strioturbonilla*) *nahuana* Baker, Hanna & Strong, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 17, No. 7, June 29, 1928, p. 211, pl. 11, fig. 5. "Gulf of California."

[115] *Chemnitzia affinis* C. B. Adams, *Ann. Lyceum Na Hist. New York*, Vol. 5, July, 1852, pp. 389, 535 (separat pp. 165, 311). "Panama."—Dall & Bartsch, *U. S. Nat. Mus Bull.* 68, 1909, p. 56, pl. 4, fig. 14 (as *Turbonilla* (*Strioturb bonilla*) *affinis*).

[116] *Chrysallida convexa* Carpenter, Cat. Mazatlan Shell December, 1856, p. 424. "Hab.-Mazatlan; 2 sp. off Spon dylus; L'pool Col."—Dall & Bartsch, *U. S. Nat. Mus., Bul* 68, 1909, p. 135, pl. 18, fig. 4 (as *Odostomia* (*Besla convexa*).

that the spiral sculpture occurs over most the surface of the whorls rather than ing confined to the lower third.

The name of this species is derived from Canelo, Cinnamon Bay, the Spanish name r Port Parker, Costa Rica.

Subgenus **Chrysallida** Carpenter.

Odostomia (Chrysallida) costaricensis
Hertlein & Strong, sp. nov.
Plate VII, Fig. 9.

Shell small, elongate-conic, white; nucleus ith a slightly elevated spire having the axis an oblique angle with that of the follow-g whorls, in the first of which it is about ne-half immersed; normal whorls 7, almost at-sided; axial sculpture of strong, retrac-ve ribs of which 16 appear on the first whorl, ncreasing to 24 on the last whorl; spiral culpture of cords a little less strong than ne axial ribs of which 4 appear on the upper horls, the upper one, just below the suture ather indistinct; on the fourth whorl a ender cord begins to appear in the su-ure, rapidly increases in size until on the enultimate whorl it equals the preceding ne in strength and spacing; the intersec-ions of the axial ribs and the upper 4 cords re slightly nodulous and the spaces enclosed y them appear as nearly square pits, the fth cord is smooth; periphery marked by smooth cord about as strong as the one receding it; base rather long, marked by strong cords, with, in the interspaces, nu-nerous fine axial threads; aperture ovate, uter lip thin, columella slender, somewhat eflected, with a slight fold at its insertion. The type measures: length, 2.9 mm.; diam-eter, 0.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud. Additional speci-mens were dredged at Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, in 15 fathoms (27 meters), sandy mud, crushed shell.

The shell of this species differs from that of *Odostomia* (*Chrysallida*) *olssoni* Bartsch[117] in that there are 24 rather than 18 axial ribs on the penultimate whorl.

Odostomia (Chrysallida) woodbridgei
Hertlein & Strong, sp. nov.
Plate III, Fig. 8.

Shell small, elongate-conic, white; nucleus with a slightly elevated spire having the axis at nearly a right angle to that of the follow-ing whorls, in the first of which it is about one-half immersed; normal whorls 6, slightly rounded; axial sculpture of strong, slightly retractive ribs of which 16 appear on all whorls; spiral sculpture of raised cords not quite as strong as the ribs, 4 appearing on the first 2 whorls, on about the third whorl the upper cord splits and continues on the re-mainder of the whorls as two closely spaced weak cords, the following 3 cords are much stronger and more widely spaced, on about the fourth whorl a sixth cord be-gins to appear in the suture and rapidly in-creases in size until on the penultimate whorl it equals the preceding cords in strength and spacing; the intersections of the axial ribs and the upper 5 spiral cords are slightly nod-ulous and the spaces inclosed between the ribs and the 3 median cords appear as deep rectangular pits, the sixth cord is smooth and the space between it and the preceding cord is crossed by feeble extensions of the axial ribs; periphery rounded, marked by a smooth cord about as strong as the preced-ing one; base rather long, marked by 5 strong spiral cords, with, in the interspaces, numer-ous fine axial threads; aperture ovate, outer lip fractured in the type, columella slender, somewhat reflected, with a strong fold at its insertion. The type measures: length, 2.3 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters), shelly mud, crushed shell. Ad-ditional specimens were dredged at Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, in 12 fathoms (22 meters), shelly mud.

This species differs from such species as *Odostomia* (*Chrysallida*) *olssoni* Bartsch in that there are 6 rather than 5 spiral cords on the penultimate whorl.

This species is named for Mr. Woodbridge Williams of Inverness, California, who has presented many fine specimens of mollusks to the California Academy of Sciences.

Odostomia (Chrysallida) guatulcoensis
Hertlein & Strong, sp. nov.
Plate VII, Fig. 2.

Shell small, elongate-ovate, vitreous; nu-cleus decollated; normal whorls 5, almost flat-sided; sculptured with broad spiral cords with narrow interspaces, bearing axially elongated nodules arranged in retractive axial rows on the upper whorls, 24 rows ap-pearing on the penultimate whorl, on about the third whorl a fifth smooth cord begins to appear in the suture and rapidly increases in strength until on the penultimate whorl it equals the others in strength and spacing; periphery marked by a smooth cord slightly narrower than the one preceding it; base short, marked with 5 strong cords; aperture ovate, outer lip thin, columella appressed to the base, with a strong fold at its insertion. The type measures: length, 2.0 mm.; diam-eter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

117 *Odostomia* (*Chrysallida*) *olssoni* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 66, No. 2551, Art. 14, October 17, 1924, p. 7, pl. 2, fig. 3. From "Santa Elena Bay, Ecuador."

The shell of this species differs from that of *Odostomia* (*Chrysallida*) *promeces* Dall & Bartsch[118] in that the base is sculptured with 5 rather than 3 spiral cords.

Odostomia (Chrysallida) corintoensis
Hertlein & Strong, sp. nov.
Plate VIII, Fig. 11.

Shell large, elongate-ovate, white; nucleus having a depressed helicoid spire with the axis at right angles to that of the following whorls, in the first of which it is deeply immersed; normal whorls 7, flat-sided, separated by deep sutures; axial sculpture of strongly protractive ribs of which 20 appear on the second whorl, increasing to 24 on the penultimate whorl; spiral sculpture of cords about as strong as the axial ribs, of which 5 appear on the first four whorls, on about the fifth whorl a slender cord begins to appear in the suture which rapidly increases in strength until on the penultimate whorl it equals the others in strength and spacing; the intersections of the axial ribs and the first 5 cords are somewhat nodulous while the sixth cord is smooth; periphery marked by a strong cord; base rather long, marked with 5 spiral cords; the spaces between the fifth and sixth cords, between the sixth and peripheral cords, and between the basal cords are marked with fine axial threads; aperture oval, outer lip thin, columella appressed to the base with a strong fold at its insertion. The type measures: length, 4.0 mm.; diameter, 1.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Corinto, Nicaragua, collected in beach drift.

The shell of this species is similar to that of *Odostomia* (*Chrysallida*) *capa* Bartsch[119] but among other differences it exceeds 3 mm. in length whereas Bartsch's species is less than 3 mm. in length.

Telloda Hertlein & Strong, subgen. nov.

Type: *Odostomia* (*Scalenostoma*) *dotella* Dall & Bartsch, 1909.

Shell with the angulation high upon the posterior portion of the whorls.

Dall & Bartsch, 1909, included *Odostomia dotella* under the subgenus *Scalenostoma* Deshayes. Bartsch[120], 1917, considered *Scalenostoma* to be a genus in the family Melanellidae and included in it two species, *S. rangii* de Folin and *S. babylonia* Bartsch. This left *Odostomia dotella* without a subgeneric assignment. The high angulation on the whorls of *O. dotella* and of the new species here described as *O. subdotella* furnish shell characters so different from the other west American species of *Odostomia* that we have been led to propose a new subgenus *Telloda*[121] to include them.

Key to the species of *Telloda*.

A. Angulation on penultimate whorl at anterior third of whorl; a spiral cord present on angulation..................... *subdotella*
B. Angulation on penultimate whorl at less than anterior third of whorl; angulation lacking a spiral cord........................ *dotella*

Odostomia (Telloda) subdotella
Hertlein & Strong, sp. nov.
Plate VIII, Fig. 5.

Shell elongate-conic, white, with the nucleus tilted at an oblique angle and almost entirely immersed in the first of the following whorls; normal whorls 7, the lower whorls strongly angulated, the first 2 whorls slightly rounded, separated by a deep suture; middle whorls flattened with an angulation and point of greatest diameter at an increasing distance above the suture, until on the penultimate whorl the angulation is at the anterior third with the surface from there to the summit slightly concave and the slope to the suture very abrupt; entire surface with microscopic lines of growth and indistinct spiral striation; base moderately long, flattened; aperture ovate, outer lip thin, slightly angulated in the middle, columella curved, with a slight fold at its insertion. The type measures: length, 2.9 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters), sandy mud, crushed shell. Additional specimens were dredged at Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., Corinto, Nicaragua, in 12-13 fathoms (22-24 meters), mangrove leaves.

Subgenus **Evalea** A. Adams.

Odostomia (Evalea) gallegosiana
Hertlein & Strong, sp. nov.
Plate VIII, Fig. 1.

Shell regularly elongate-conic, white; nucleus deeply immersed in the first of the following whorls with only the tilted edge appearing, giving the apex a truncated appearance; normal whorls 6, almost flat-sided, separated by a narrow, deep suture; entire surface with microscopic spiral striations and equally fine lines of growth; periphery subangulated, base short, rounded; aperture irregular in the type, due to a fracture which has been partially mended; columella short, curved, with a raised edge separated from the body whorl by a shallow groove but showing no umbilical pit, the fold at the insertion strong. The type measures: length, 2.8 mm.; diameter, 1.1 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port

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118 *Odostomia* (*Chrysallida*) *promeces* Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, December 13, 1909, p. 164, pl. 18, figs. 2, 2a. "Todos Santos Bay, Lower California."

119 *Odostomia* (*Chrysallida*) *capa* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 69, No. 2646, Art. 20, December 16, 1926, p. 15, pl. 2, fig. 4. "on the coast southeast of Punta Santa Elena, Santa Elena Peninsula, Ecuador."

120 Bartsch, P., *Proc. U. S. Nat. Mus.*, Vol. 53, No. 2207, August 13, 1917, p. 337.

121 *Telloda*, anagram of dotella.

[G]uatulco, Mexico, dredged in 7 fathoms [(]12.6 meters), gr. sand, crushed shell. Speci[m]ens were also dredged at Station 200-D-19, [L]at. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., [C]orinto, Nicaragua, dredged in 12-13 fa[th]oms (22-24 meters), mangrove leaves.

The shell of this species differs from that [o]f such species as *Odostomia* (*Evalea*) [*v*]*arella* Dall & Bartsch and *Odostomia* (*Eva*[*le*]*a*) *palmeri* Bartsch in that the periphery [o]f the body whorl is subangulated rather [t]han well rounded.

This species is named for Professor José [M]aria Gallegos, former explorer for the De[p]artamento de Agricultura y Fomento, [M]exico.

Subgenus **Evalina** Dall & Bartsch.

Odostomia (Evalina) tehuantepecana

Hertlein & Strong, sp. nov.

Plate VIII, Fig. 7.

Shell small, elongate-conic, translucent, [w]hite; nucleus having the axis at nearly [r]ight angles to that of the following whorls, [i]n the first of which it is deeply immersed [w]ith only the tilted edge appearing; normal [w]horls 5, rounded, rather broad between the [s]utures; axial sculpture of strong ribs, on [t]he first 2 whorls extending from suture to [s]uture, on the third whorl fading out on the [l]ower portion and on the penultimate whorl [o]nly occupying the upper half, 16 appearing [o]n the penultimate whorl; spiral sculpture [o]f flattened cords separated by shallow in[c]ised lines, 4 appearing in the interspaces between the ribs and 4 between the lower end of the ribs and the following suture on the penultimate whorl; periphery rounded, marked with a slender cord; base rounded, marked with 8 spiral cords similar to that on the periphery; aperture somewhat flaring, oval, outer lip thin, showing the spiral sculpture plainly within, columella short, curved, with a weak fold at its insertion. The type measures: length, 2.3 mm.; diameter, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The shell of this species differs from that of *Odostomia* (*Evalina*) *intermedia* Carpenter[122] in that on the summit of the whorls the axial ribs are strong rather than feeble.

Subgenus **Menestho** Möller.

Odostomia (Menestho) nicoyana

Hertlein & Strong, sp. nov.

Plate VIII, Fig. 3.

Shell elongate-conic, white; nucleus with an elevated spire having the axis at right angles to that of the following whorls, in the first of which it is deeply immersed, the tip deeply notching the edge; normal whorls 7, flat-sided, regularly increasing in size; sculpture on all whorls of 3 strong, sharp edged cords with deep, rounded interspaces, crossed by fine axial threads, of these cords the anterior is somewhat stronger than the other 2; periphery angulated, marked by a cord only a little less strong than those on the spire; base short, slightly rounded, marked with 4 spiral cords, the first a little below the peripheral cord and about as strong, this is followed by a smooth space and then 3 closely spaced, much finer cords; aperture subquadrate, outer lip thin, rendered wavy by the spiral cords, columella short, curved, with a strong fold at its insertion. The type measures: length, 3.3 mm.; diameter, 1.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud. Additional specimens were dredged at Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, in 15 fathoms (27 meters), sandy mud, crushed shell.

The shell of this species differs from that of *Odostomia* (*Menestho*) *ciguatanis* Strong[123] in that the anterior cord between the sutures is stronger than the other two whereas in the species described by Strong the cords are equal and are separated by narrower interspaces.

Subgenus **Miralda** A. Adams.

Odostomia (Miralda) rhizophorae

Hertlein & Strong, sp. nov.

Plate VII, Fig. 1.

Shell very small, elongate-ovate, white; nucleus almost completely immersed in the first of the following whorls, above which only the tilted edge projects; normal whorls 6; spiral sculpture between the sutures of 2 nodulous keels, of which the upper is just below the suture while the lower is some distance above the following suture, nodules on the upper keel axially elongated and on the lower keel well rounded; axial sculpture of low ribs connecting the nodules and extending as weaker threads between the lower keel and the edge of the peripheral keel which is exposed in the suture, 24 appearing on the penultimate whorl; periphery marked by a rather broad, almost smooth keel; base short, marked by 3 spiral keels, with, in the interspaces, axial threads corresponding to the axial ribs; aperture ovate, outer lip fractured in the type, columella strong, curved, with a weak fold at its insertion. The type measures: length, 2.1 mm., diameter, 1.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

122 *Dunkeria intermedia* Carpenter, Cat. Mazatlan Shells, December, 1856, p. 435. "Hab.-Mazatlan; 2 sp. off Spondylus; L'pool Col."—Dall & Bartsch, *U. S. Nat. Mus., Bull.* 68, 1909, p. 181, pl. 20, fig. 6 (as *Odostomia* (*Evalina*) *intermedia*).

123 *Odostomia* (*Menestho*) *ciguatanis* Strong, *Bull. South. Calif. Acad. Sci.*, Vol. 48, Pt. 2, May-August (issued November 4), 1949, p. 89, pl. 12, fig. 3. "Gulf of California without definite location."

The shell of this species differs from that of species such as *Odostomia* (*Miralda*) *armata* Carpenter in that the base is sculptured with 4 rather than 3 spiral cords.

Superfamily Taenioglossa.

FAMILY CERITHIOPSIDAE.

Genus **Cerithiopsis** Forbes & Hanley.

Cerithiopsis guatulcoensis

Hertlein & Strong, sp. nov.

Plate VII, Fig. 7.

Shell regularly elongate-conic, slender, light brown, with the whorls somewhat darker toward the summits; nucleus forming a conical spire with 4 smooth, white whorls set off from the following whorls by a sharp line; postnuclear whorls 8, slightly rounded, sutures impressed; spiral sculpture of 3 strong, nodulous cords, the posterior at the summit, the anterior a little above the suture and the median half way between the other 2, the posterior cord a little weaker than the others on all whorls; nodules somewhat spirally elongated without sharp truncation, 16 appearing on the first whorl, increasing to 20 on the penultimate whorl, the nodules connected by slender axial threads, those between the anterior and median cord being nearly vertical, while those between the median and posterior cords are strongly retractive; the spaces enclosed by the axial threads and the anterior and median spiral cords form square pits and those between the median and posterior spiral cords form a parallelogram; periphery marked by a slender cord separated from the anterior cord by a space about as wide as that between the anterior and median cords and rendered slightly nodulous by the extensions of the axial threads; base very short, with an incised line encircling the columella and faint axial striae corresponding to the extensions of the axial threads; aperture subquadrate, strongly channeled anteriorly, outer lip thin, scalloped by the spiral cords, columella short, slightly curved. The type measures: length, 3.7 mm.,; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell. Additional specimens were dredged at Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., Corinto, Nicaragua, in 12-13 fathoms (22-24 meters), mangrove leaves. A specimen from this locality with the two lower nuclear whorls, 9 postnuclear whorls and a broken aperture measures: length, 5.1 mm.; diameter, 1.5 mm.

The pits between the spiral cords on the shell of this species are unequal rather than equal as on *Cerithiopsis grippi* Bartsch.[124]

[124] *Cerithiopsis* (*Cerithiopsis*) *grippi* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 52, No. 2193, May 29, 1917, p. 669, pl. 46, fig. 12. "in 15 fathoms, outside of kelp, off San Diego Bay, California."

Cerithiopsis guanacastensis

Hertlein & Strong, sp. nov.

Plate VII, Fig. 10.

Shell regularly elongate-conic, dark brown with the top of the tubercles paler; nuclear whorls broken with only a portion of the last whorl remaining which is smooth except for a sharp central keel; postnuclear whorls 11, sculptured with 3 spiral cords and almost equally strong axial ribs, of which 16 appear on the first whorl, increasing to 24 on the penultimate whorl; the intersection of the spiral cords and axial ribs forming large, raised tubercles and the spaces enclosed by them deep, square pits; on the spiral cords the posterior is at the summit of the whorls and the anterior a little above the suture with the median about half way between them; the tubercles of the posterior spiral row rounded, rather faint on the first 2 or 3 whorls but slightly the largest on the later whorls, the tubercles of the median and anterior row somewhat truncated on the posterior face; periphery with a spiral cord only a little less strong than those on the spire and rendered somewhat nodulous by the extensions of the axial ribs; base short, rounded, with 2 spiral cords of which the upper is nearer to the peripheral cord than to the lower, entire surface of spire and base with microscopic striations; aperture subquadrate, outer lip thin, scalloped by the spiral cords, anterior channel strong, columella short, not reflected. The type measures: length, 6.2 mm.; diameter, 2.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Long Beach NW. of Port Parker, Costa Rica.

The base of the shell of this species is sculptured with 2 unequal cords in comparison to 3 equal cords on *Cerithiopsis cosmia* Bartsch.[125]

Cerithiopsis perrini

Hertlein & Strong, sp. nov.

Plate VII, Fig. 5.

Shell minute, pupiform, light chestnut brown; nuclear whorls forming a slender, white spire, the first whorl smooth, the remainder with closely spaced retractive axial threads of which about 20 appear on the last whorl; postnuclear whorls 5½, spiral sculpture of, on the first whorl, 2 nodulous cords, of which the posterior is much the smaller, on the second whorl it rapidly increases in strength and the tubercles become axially elongated, while on the third whorl this cord is split into 2 distinct, closely spaced cords, which on the penultimate whorl about equal the anterior cord in strength; axial sculpture of somewhat retractive ribs connecting the tubercles, 14 appearing on the first whorl, increasing to 18 on the penultimate whorl, the spaces enclosed by the axial cords and the posterior and median cords appearing as

[125] *Cerithiopsis cosmia* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 33, No. 1564, October 23, 1907, p. 180. "Whites Point, San Pedro." California.—Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 40, No. 1823, 1911, p. 348, pl. 38, fig. 7 (as *Cerithiopsis* (*Cerithiopsidella*) *cosmia*).

narrow, spirally elongated pits, and those between the median and anterior cord as irregular, squarish pits, posterior and median rows of nodules rounded, the anterior somewhat truncated posteriorly; periphery marked by a cord a little less strong than those on the spire on which the axial ribs terminate; base rather produced, with a broad, rounded cord in the middle, and a second, slightly smaller just above the insertion of the columella; aperture rounded with a short canal, outer lip thin, columella slightly reflected, body with a thin callus. The type measures: length, 1.9 mm.; diameter, 0.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N.; Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The shell of this species can be differentiated from that of *Cerithiopsis bristolae* Baker, Hanna & Strong[126] in that the posterior row of pits is narrower than the others.

This species is named for the late James Perrin Smith, Professor of Paleontology at Stanford University.

Cerithiopsis oaxacana
Hertlein & Strong, sp. nov.
Plate VII, Fig. 4.

Shell elongate-conic, chestnut brown; nuclear whorls 4, white, forming an elevated spire, smooth except for a keel at the anterior third and on the last whorl a smaller cord just above the suture; postnuclear whorls 7, slightly rounded; spiral sculpture of tuberculate cords, 2 appearing on the first two whorls, the posterior at the summit and the anterior a little above the suture, on the third whorl the nodules of the posterior cord become axially elongated with an incised line in the middle, this division increases in depth and width until on the penultimate whorl there are 3 spiral cords of about equal strength and spacing; axial sculpture of narrow, slightly retractive ribs connecting the nodules, not as strong as the spiral cords, 16 appearing on the first whorl, increasing to 22 on the penultimate whorl, the spaces inclosed between the axial ribs and spiral cords on the lower whorls appearing as well impressed, rounded pits, the posterior spiral row of nodules rounded, the median and anterior somewhat truncated on the posterior face; the periphery marked by a cord only a little less strong that those on the spire with the space between it and the anterior cord a little narrower than that between the anterior and median cords, rendered slightly nodulous by the feeble extensions of the axial ribs; base moderately long, slightly concave, with a strong, rounded cord in the middle; aperture rounded, with a short canal, the edge of the outer lip fractured, columella curved, strongly reflected, body with a strong callus. The type measures: length, 2.6 mm.; diameter 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The tubercles ornamenting the shell of this species are truncated posteriorly whereas on such forms as *Cerithiopsis pupiformis* Carpenter[127] the tubercles are rounded.

Family Cerithiidae.
Genus **Bittium** Leach in Gray.
Subgenus **Lirobittium** Bartsch.

Bittium (Lirobittium) arenaense
Hertlein & Strong, sp. nov.
Plate VII, Fig. 8.

Shell rather large for the genus, elongate-conic, light yellowish-brown; nuclear whorls 2, the first tilted, smooth, the second with 2 spiral keels; postnuclear whorls 11, at first regularly increasing in size and angulated in the middle, later becoming almost cylindrical and without angulation; sculptured with 3 equal spiral rows of nodules, truncated on the anterior face and connected by low spiral cords and axial ribs; the first of these rows is some distance below the suture, the last close to the following suture, and the third about halfway between the other two; periphery with a nodulous spiral cord which is more or less exposed in the suture; base short, with 5 closely spaced spiral cords, of which the upper one, just below the peripheral cord, is the strongest and somewhat nodulous; of the nodules 10 appear in each spiral row on the first whorl and about 20 on the last whorl; entire surface with microscopic lines of growth and in some places very fine intercalary spiral threads; aperture small, channeled anteriorly; outer lip thin, defective in the type, columella flexuous, body with a thin callus. The type measures: length, 10.5 mm.; maximum diameter, 2.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 136-D-22, Arena Bank, Gulf of California, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., in 45 fathoms (82 meters), mud. About 100 additional specimens were dredged at the same locality. Five specimens were dredged in the same general locality at Station 136-D-18, in 40 fathoms (73 meters), mud. 16 specimens were dredged at Station 150-D-8, Gorda Banks, Lat. 23° 05′ 00″ N., Long. 109° 30′ 00″ W., in 40-45 fathoms (73-82 meters), muddy sand.

Some of the paratypes show the peripheral keel entirely exposed in the suture as a fourth spiral row of nodes, also some of them

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126 *Cerithiopsis* (*Cerithiopsida*) *bristolae* Baker, Hanna & Strong, *Proc. Calif. Acad. Sci.*, Ser. 4, Vol. 23, No. 15, May 24, 1938, p. 219, pl. 19, fig. 4. "Cape San Lucas, Lower California."

127 *Cerithiopsis pupiformis* Carpenter, Cat. Mazatlan Shells, December, 1856, p. 443. "Hab.-Mazatlan; extremely rare, off Spondylus; L'pool Col."—Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 40, No. 1823, 1911, p. 337, pl. 38, figs. 1, 5 (as *Cerithiopsis* (*Cerithiopsis*) *pupiformis*).

show patches or bands of much darker brown.

In Bartsch's key[128] to the west American species of *Bittium* this new species would follow *Bittium oldroydae* Bartsch[129] from which it differs principally in the smaller size, less shouldered whorls and more slender form.

Family Turritellidae.

Genus *Turritella* Lamarck.

Turritella clarionensis Hertlein & Strong, sp. nov.

Plate II, Fig. 13.

Shell tapering, apical angle fairly broad, tip curved to the right, chalky white, with rather indistinct, narrow, interrupted, brown, axial lines following the lines of growth; extreme tip broken on type, remaining whorls 17; spiral sculpture consists of a rounded cord or ridge just below the suture and a similar cord a short distance above the following suture, the area between the cords concave; additional spiral sculpture of a few indistinct threads on the spire and a narrow, stronger thread on the sharply angulated periphery, separated from the lower cord by a groove and showing more or less distinctly on the spire; axial sculpture consists of rough, raised, antispiral lines of growth, which reach their maximum in about the median portion of the whorl, the spiral sinus reaches its maximum at the periphery; base flat, sculptured with curved lines of growth in some cases forming a small antispiral sinus, in addition to this there are fine spiral threads of which the 2 or 3 immediately below the periphery are the most distinct; aperture subquadrate; outer lip thin, the upper part concave and the angle at the junction with the basal lip is drawn forward into a projecting point. Dimensions of the type: length, 56 mm.; maximum diameter, 16.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 163-D-2, 3 miles off Pyramid Rock off Clarion Island, Revillagigedo Islands, Mexico, Lat. 18° 19′ 00″ N., Long. 114° 45′ 00″ W., dredged in 55 fathoms (100 meters), on rock and coral bottom. Two other specimens were dredged at the same locality. One specimen was dredged on Arena Bank, in the Gulf of California (136-D-22), Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., in 45 fathoms (82 meters), on a mud bottom. One large, eroded specimen was dredged on Hannibal Bank, Panama.

This species is somewhat similar to *Turritella cooperi* Carpenter in having two spiral ridges separated by a concave central area but it has a greater apical angle, the large antispiral sinus reaches its maximum in the middle of the whorl rather than near the lower ridge, and the color is different. The new species differs from *T. radula* and *T. mariana* in the much greater apical angle, in lacking strong spiral beaded sculpture and in the much lighter color.

The very deep antispiral sinus in the outer lip of this species is somewhat suggestive of forms from the southwestern Pacific which were placed under *Colpospira* by Donald.[130] Merriam,[131] after a study of various species of *Turritella*, concluded that "the growth-line characters of *Colpospira* are not typically Murchisonid but simply a modification of the type found in many turritellas, and that in *Colpospira* they have acquired sinus depth to a greater degree than has any other known member of this family."

Family Rissoidae.

Genus *Alvania* Leach in Risso.

Alvania? ingrami Hertlein & Strong, sp. nov.

Plate VII, Fig. 6.

Shell ovate, conic, white with the basàl cords brown; nucleus eroded; remaining whorls 6, sculptured with 10 strong rounded axial ribs most prominent on the middle of the whorls, terminating a little above the periphery, interspaces rounded, crossed by spiral threads which ride over the ribs but do not render them nodulous, these threads are indistinct on the upper whorls, about 10 appearing on the penultimate whorl; entire surface with microscopic axial striations; sutures impressed, showing 1 or 2 of the brown spiral basal cords; periphery rounded, without definite markings, base rather long, slightly rounded, with 10 spiral cords somewhat stronger than the threads on the spire; aperture somewhat oblique, posterior angle with a slight sinus and separated from the body whorl by a wedge of callus, outer lip little thickened, strongly produced, rounding into the columella, body with a strong callus. The type measures: length, 3.1 mm.; diameter, 1.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The shell of this species is somewhat similar to that of *Rissoina* (*Folinia*) *signae* Bartsch[132] but the shape of the outer lip is quite different.

This species is named for Dr. William M. Ingram, Professor of Zoology, Mills College, Oakland, California.

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[128] Bartsch, P., *Proc. U. S. Nat. Mus.*, Vol. 40, 1911, pp. 389-390.

[129] *Bittium oldroydae* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 40, No. 1826, May 12, 1911, p. 408, pl. 51, fig. 5. "The type was collected in drift in Lower California." Specimens also from Destruction Island, Washington.

[130] *Colpospira* Donald, *Proc. Malacol. Soc. London*, Vol. 4, No. 2, August 1, 1900, p. 51. "Type.—*Turritella runcinata*, Watson." Illustrated on pl. 5, figs. 7, 7a. Bass Strait between Australia and Tasmania.

[131] Merriam, C. W., *Univ. Calif. Publ. Bull. Dept. Geol. Sci.*, Vol. 26, No. 1, March 8, 1941, p. 19.

[132] *Rissoina* (*Folinia*) *signae* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 49, July 24, 1915, p. 61, pl. 31, figs. 1 and 4. "The type, which is said to come from Negrito Island (loc. ?) or Margarita Island, Bay of Panama."=*Rissoa insignis* De Folin, Les Méléagrinicoles, (Havre), 1867, pp. 48-49, pl. 5, figs. 2 and 3. Not *Rissoa insignis* Adams & Reeve, 1850.

FAMILY RISSOINIDAE.

Genus **Rissoina** d'Orbigny.

Rissoina alarconi
Hertlein & Strong, sp. nov.
Plate VIII, Fig. 12.

Shell elongate-conic, white; nuclear whorls 3, smooth, well rounded; postnuclear whorls 6, rounded, with the point of greatest diameter a little above the impressed suture; axial sculpture of low, strongly protractive ribs which fade out at the suture, of these 18 appear on the first whorl, increasing to about 40 on the penultimate whorl; spiral sculpture of slender threads in the interspaces between the ribs, 10 appearing on the first whorl, increasing to 16 on the penultimate whorl; on the first whorl a median spiral thread is much the strongest, angulating the whorl, and a second, just above the suture, is only a little less strong, on the second whorl the median thread fades out while the one above the suture remains the strongest throughout the remaining whorls, the remainder of the threads being subequal and subequally spaced; periphery rounded, base somewhat produced, with 15 spiral cords distinctly stronger than the spiral threads on the spire, with, in the interspaces on the upper part of the base, feeble extensions of the axial ribs; aperture ovate, slightly channeled posteriorly and anteriorly, outer lip with a thick callus immediately behind the edge, body with a strong callus. The type measures: length, 4.8 mm.; diameter 1.8 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N.; Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud. Specimens also were dredged at Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, in 12-13 fathoms (22-24 meters), mangrove leaves.

This species bears a resemblance to *Rissoina townsendi* Bartsch[133] but differs in that the axial ribs are much more protractive.

This species is named for Hernando de Alarcón, Admiral of the Spanish Viceroy Mendoza, who in 1540 sailed to the headwaters of the Gulf of California.

Rissoina axeliana Hertlein & Strong, sp. nov.
Plate III, Fig. 6.

Shell small, elongate-conic, translucent, white; nuclear whorls 3, well rounded, smooth; postnuclear whorls 5, well rounded, with the sutures impressed; axial sculpture absent; spiral sculpture of indistinct threads, about 16 appearing on the penultimate whorl, of which the one immediately below the suture is slightly the widest and separated from the following thread by a distinct incised line, thus forming a slightly impressed band at the summit of the whorls; periphery well rounded, base somewhat produced, sculptured with fine spiral threads similar to those on the spire; aperture large, ovate, outer lip with a slight constriction at the posterior angle, rounding into the basal lip, thin at the edge, reinforced by a slight callus, columella narrow, curved, body without callus. The type measures: length, 2.4 mm.; diameter, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell.

The present specimens may not be fully mature and it appears possible that the outer lip might become more thickened with the addition of another whorl.

This species bears a resemblance to *Rissoina lapazana* Bartsch[134] but differs in possessing a much smaller shell which is more finely sculptured.

This species is named for Axel A. Olsson who has made many contributions to the knowledge of the Cenozoic mollusks of South and Central America.

Subgenus **Folinia** Crosse.

Rissoina (Folinia) ericana
Hertlein & Strong, sp. nov.
Plate VIII, Fig. 10.

Shell elongate-conic, white; nucleus with 4 well rounded, translucent whorls separated from the postnuclear whorls by a distinct line; postnuclear whorls 6, rounded, narrowly shouldered at the summit; axial sculpture of strong, retractive, sinuous ribs forming sharp points at their summits which project over the suture, of these ribs 12 appear on the first postnuclear whorl, increasing to 18 on the penultimate whorl; spiral sculpture of raised threads which ride over the ribs rendering them slightly tuberculate, rather indistinct on the upper whorls, strong on the penultimate whorl where 16 appear; periphery rounded, marked by a narrow incised line; base produced with a strong fasciole anteriorly, sculptured with strong continuations of the axial ribs which cross the fasciole to the umbilical region, and 7 spiral threads similar to those on the spire above the fasciole which is finely spirally threaded; aperture oval with a small area at the posterior angle set off by a denticle on the outer lip; outer lip rounded at the edge, reinforced by a strong callus rendered nodulous by the ends of the spiral cords; anterior end of aperture slightly channeled, columella strong, curved, body with a slight callus. The type measures: length, 3.0 mm.; diameter, 1.2 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters), gr. sand, crushed shell. Specimens also were dredged at Station 203-D-3,

133 *Rissoina townsendi* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 49, No. 2094, July 24, 1915, p. 48, pl. 29, fig. 3. Dredged at "Agua Verde Bay, Lower California."

134 *Rissoina lapazana* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 49, No. 2094, July 24, 1915, p. 50, pl. 30, fig. 6. "dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 2823 in 26½ fathoms on broken shell bottom off La Paz, Gulf of California."

Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud.

This species resembles *Rissoina* (*Folinia*) *signae* Bartsch[135] but differs in that the axial ribs are more numerous and the whorls are less shouldered.

This species is named for Eric Knight Jordan, formerly Assistant Curator of the Department of Paleontology, California Academy of Sciences.

Family Vanikoridae.

Genus **Vanikoro** Quoy & Gaimard.

Vanikoro galapagana

Hertlein & Strong, sp. nov.

Plate XI, Figs. 7, 8.

Shell naticoid, thin, white, with about 2 nearly smooth nuclear whorls and a little over 2 well rounded and finely sculptured normal whorls; sculpture at first of 3 spiral cords or ridges which steadily increase in number but not in strength until at the outer lip there are about 20 fine threads, these are crossed by nearly equally strong and equally spaced lines of growth, slightly nodulous at the intersections, at first this sculpture has a cancellated appearance but later appears as a more widely spaced net of fine lines; aperture semilunate, oblique, outer lip thin, regularly curved, columella slightly curved, ending posteriorly in a thin callus spreading over the body of the shell; umbilicus narrow, deep; operculum corneous, thin. Dimensions of holotype: height of shell, 7.5 mm.; diameter 13.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 54, Hood Island, Galapagos Islands, collected by the *Arcturus* Expedition, 1925.

The early whorls of this species bear cancellated sculpture and somewhat resemble those of *Vanikoro aperta* Carpenter[136] originally described from Cape San Lucas, Lower California. The shell of that species is sculptured with stronger, more nodulose spiral threads.

Superfamily Rhipidoglossa.

Family Liotiidae.

Macrarene Hertlein & Strong, gen. nov.

Type: *Liotia* (*Arene*) *californica* Dall, *Bull. Mus. Comp. Zool.*, Vol. 43, No. 6, October, 1908, p. 344. "U. S. S. 'Albatross,' station 2984[137], off Lower California, in 113 fathoms, sand, bottom temperature 49.8° F." —Strong, *Trans. San Diego Soc. Nat. Hist.*, Vol. 7, No. 37, 1934, p. 441, pl. 28, figs. 4, 5, 6.

Shell depressed turbinate, with strong peripheral projections. The surface is sculptured with both spiral cords and axial ribs or threads. The two species placed in this genus, described as *Liotia* (*Arene*) *californica* Dall and *Liotia* (*Arene*) *pacis* Dall, are much larger than the other west American species of *Liotia* and *Arene*.

Family Vitrinellidae.

Genus **Cyclostrema** Marryat.

Cyclostrema gordana

Hertlein & Strong, sp. nov.

Plate IX, Figs. 3, 4, 7.

Shell small, depressed, white; nuclear whorls 2, very small, smooth, projecting very little above the succeeding whorls; postnuclear whorls a little more than 3, rapidly increasing in diameter; distinctly sculptured with equal, spiral cords, of which the first is some distance below the suture, from which it is separated by a broad concave area, while the following 4 are much more closely spaced, the last of these cords forms the upper edge of a broad, flattened, spirally striated periphery; base slightly convex, with 3 spiral cords, the upper one forming the lower edge of the flattened periphery, the other 2 forming a closely spaced pair at the edge of the umbilicus; umbilicus wide, deep, showing all the whorls within; entire surface of the shell with fine axial lines which near the aperture and on the inside of the umbilicus become narrow, curved folds; aperture circular, thickened within, the edge thin with the spiral cords forming small, projecting points; peristome continuous, flattened and with callus over the body of the shell. Dimensions of type: maximum diameter, 9.7 mm.; minimum diameter, 7.0 mm.; height, 3.3 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), dredged at Station 150-D-8, Lat. 23° 05′ 00″ N., Long. 109° 30′ 00″ W., Gorda Banks, Gulf of California, in 40-45 fathoms (73-82 meters), muddy sand.

The unique type of this new species is very similar to *Cyclostrema angulata* A. Adams[138] from the West Indies, differing principally in the smaller size and more depressed form.

Genus **Cyclostremiscus** Pilsbry & Olsson.

Cyclostremiscus humboldti

Hertlein & Strong, sp. nov.

Plate X, Fig. 1.

Shell sharply angulated and keeled, white; nuclear whorls 2, rounded, smooth, shining, forming a flattened apex, set off from the following whorls by a well defined line; postnuclear whorls a little over 2, with a sharply

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[135] *Rissonia* (*Folinia*) *signae* Bartsch, *Proc. U. S. Nat. Mus.*, Vol. 49, No. 2094, July 24, 1915, p. 61, pl. 31, figs. 1, 4. New name for *Rissoa insignis* de Folin, 1867, not *Rissoa insignis* Adams & Reeve, 1850. "The type which is said to come from Negrito Island (loc.?) or Margarita Island, Bay of Panama."

[136] *Narica aperta* Carpenter, *Ann. & Mag. Nat. Hist.*, Ser. 3, Vol. 13, June, 1864, p. 476. Reprint in *Smithson. Miscell. Coll.*, No. 252, 1872, p. 215. "Cape St. Lucas." Lower California.

[137] In the list of dredging stations of the "Albatross," Station 2984 is cited as located in Lat. 21° 14′ 53″ N., Long. 157° 51′ 10″ W., in 50 fathoms.

[138] *Cyclostrema angulata* A. Adams, *Proc. Zool. Soc. London*, November 12, 1850, p. 44. "Hab. in insulis Philippinis." "Hab. Sibonga, island of Zebu, 10 fathoms, sandy mud; H. C. (Mus. Cuming)."—Sowerby Thes. Conch., Vol. 3, 1863, p. 250, pl. 255, figs. 1, 2. Philippine Archipelago. Pilsbry (Man. Conch., Vol. 10, 1888, p. 92, pl. 32, figs. 63, 64, 65) stated that the locality, Philippine Islands, originally cited, needs confirmation and that "There can be no doubt of the identity with this species of *C. Beaui*, Fischer (fig. 63), a West Indian species."

keeled angle at the shoulder and another at the periphery which projects over the suture, leaving the upper portion exposed on the spire, the space between the upper keel and the suture flat and that between the upper keel and the peripheral keel deeply concave; base flatly sloping to a blunt angle bounding the deep, open umbilicus; entire surface with spiral threads, 4 appearing between the shoulder and the suture, 4 between the shoulder and peripheral keels, 6 on the base, and similarly spaced within the umbilicus; interspaces between the spiral threads crossed by finer axial threads, giving the surface a finely pitted appearance; aperture subquadrate, outer lip thin, sharp, angulated by the keels, inner lip curved, continuous over the body of the shell but scarcely attached. The type measures: maximum diameter, 1.8 mm.; height 1.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N.; Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 metres), shelly mud.

This species appears to belong in a group which includes *Cyclostremiscus trigonatus* Carpenter and *C. janus* C. B. Adams, but it differs from those species, as illustrated by Pilsbry & Olsson[139], in the higher spire and more sharply angulated whorls.

This species is named for the famous explorer Baron Alexander von Humboldt, who contributed so much to the knowledge of South America.

Genus **Circulus** Jeffreys.

Circulus taigai Hertlein & Strong, sp. nov.

Plate X, Figs. 6, 8, 9.

Shell depressed, translucent, white, shining; nuclear whorls 2, rounded smooth; postnuclear whorls 2, sculptured with a strong cord or keel half way between the suture and periphery which terminates abruptly a little short of the aperture, periphery with a narrow flattened space with a strong cord on each side, base with a fourth cord, the 4 cords being about equal in strength and spacing; umbilicus moderately wide, deep, bounded by a tumid, opaque area which rises to form a fifth cord near the aperture; entire surface between the cords with microscopic lines of growth; aperture rounded, outer lip somewhat thickened, slightly angulated by the spiral cords, parietal wall with a strong callus. The type measures: maximum diameter, 2.0 mm.; height, 1.0 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), collected in beach drift at Corinto, Nicaragua. Additional specimens were dredged at Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

This species is named for Frank Taiga, who accompanied the expedition during which the type specimen of this species was collected, and who demonstrated remarkable skill in the capture of sea and shore life.

Circulus bailyi Hertlein & Strong, sp. nov.

Plate IX, Figs. 2, 6, 9.

Shell minute, depressed, translucent, white; nuclear whorls 2, smooth, rounded, slightly projecting; postnuclear whorls 2, sculptured with a fine spiral cord just below the impressed suture, followed by a rather wide, flat-topped cord, and 4 narrow, closely spaced, sharp cords of which the last 2 are on the periphery; base convex, smooth; entire surface with microscopic lines of growth; umbilicus moderately wide, deep, with the columellar walls rounded; aperture oblique, outer lip thin, notched by the ends of the spiral cords, body with a thin wash of callus. The type measures: maximum diameter, 2.1 mm.; height, 0.9 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), collected in beach drift at Corinto, Nicaragua. Additional specimens were dredged at Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

This species is named for Dr. Joshua L. Baily, Jr., of San Diego, California.

Genus **Scissilabra** Bartsch.

Scissilabra martensiana

Hertlein & Strong, sp. nov.

Plate IX, Figs. 1, 5, 10.

Shell minute, discoidal, with the apex rising only slightly above the body whorl, semitransparent, white; whorls about 4, rapidly enlarging, without visible division into nuclear and postnuclear whorls; suture distinct but not deeply impressed; surface smooth; periphery evenly rounded; umbilicus wide, extending to the apex, the parietal walls flattened, sculptured with 3 spiral threads; aperture subquadrate, outer lip thin, truncated and slightly concave in the middle, columella strongly curved, body with a thin callus. The type measures: maximum diameter, 1.5 mm.; height, 0.5 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from beach drift at Corinto, Nicaragua. Additional specimens were dredged at Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters), mangrove leaves.

The sinus of the outer lip of this form is not as distinct as it is in other species placed in the genus *Scissilabra* but it seems to be referable to this genus. The absence of sculpture or angulation of the whorls will serve to distinguish it from other species previously placed in this genus.

This species is named for the well known conchologist Eduard von Martens, whose monumental volume dealing with mollusks forms a portion of Biologia Centrali-Americana.

[139] See Pilsbry, H. A., and A. A. Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 97, December 27, 1945, p. 268, pl. 27, figs. 2, 2a, 2b, and p. 270, pl. 27, figs. 5, 5a, 5b.

Genus **Teinostoma** A. Adams.

Teinostoma herbertiana

Hertlein & Strong, sp. nov.

Plate IX, Figs. 8, 11, 12.

Shell minute, translucent, white, shining, spire almost flatly depressed; nuclear whorls 2, set off from the following whorls by an indistinct line; postnuclear whorls 2½, sculptured with microscopic lines of growth and a low spiral cord immediately below the flatly impressed suture which on the last whorl becomes a sharp keel on the angulated periphery; under high magnification it can be observed that the upper portions of the shell are covered with very fine dots arranged in a concentric and radial pattern resembling that of a printed image through a halftone screen except that the dots are light rather than dark and on the basal portion of the shell the sculpture consists of very fine concentric lines; base moderately convex, umbilicus entirely covered by a heavy, slightly swollen callus pad; aperture somewhat oblique, circular, outer lip thin. The type measures: maximum diameter, 1.5 mm.; height, 0.7 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud. Specimens were dredged also at Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, in 15 fathoms (27 meters), sandy mud, crushed shell.

The flattened spire and sharply angulated and keeled periphery are very distinctive characters of this species. The type is probably not quite fully mature. The shape of the shell of this species bears a general resemblance to that of *Teinostoma percarinatum* Pilsbry & Olsson[140]. The shell of the species here described as new is more carinate, the aperture is more elongately ovate and the exterior is sculptured with fine dots and lines whereas no mention is made of microscopic sculpture in the original description of *T. percarinatum*.

This species is named for the late Herbert N. Lowe who collected extensively along the west coast of North Amrica.

Teinostoma zacae

Hertlein & Strong, sp. nov.

Plate X, Figs. 11, 12, 13.

Shell minute, naticoid, with the spire moderately elevated, shining, white; nuclear whorls about 2, smooth, rounded; postnuclear whorls 2½, evenly rounded, smooth except for microscopic axial striations which are most distinct immediately below the suture; periphery and base rounded; outer lip slightly thickened; inner portion of basal lip and inner lip sharply raised, continuing over the body as a raised callus, retractively waved at the periphery; a callus tongue begins at the middle of the basal lip, curves over the base and terminates abruptly at the edge of the small open umbilicus. The type measures: maximum diameter, 2.0 mm.; height 1.1 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters), shelly mud.

This species is not typical of the genus *Teinostoma* but seems referable to that genus rather than to any other recorded from the west coast. The species here described evidently is somewhat like the unfigured *Teinostoma bibbiana* Dall[141] from San Diego, California, which is described as having "only a small linguiform pad behind the pillar lip."

Genus **Anticlimax** Pilsbry & McGinty.

Subgenus **Subclimax** Pilsbry & Olsson.

Anticlimax (Subclimax) willetti

Hertlein & Strong, sp. nov.

Plate IX, Figs. 13, 14, 15.

Shell large for the genus, depressed, white; nuclear whorls 2, rounded, smooth, shining; postnuclear whorls 2½, sculptured with closely spaced, equal, spiral threads crossed by much finer, incised, axial lines; sutures flatly impressed, periphery well rounded; body whorl produced, aperture oblique, outer lip thickened at the edge, with a blunt point at the junction with the elongated basal lip, which continues as a broad callus over the body of the shell, extending to the periphery; umbilical area covered with the heavy tongue of callus, extending from about the middle of the basal lip and extending nearly to the periphery, wider and bulging over the middle of the umbilical area; exposed portion of the base moderately rounded, sculptured similar to the spire, with in addition a series of broad folds extending from a little below the periphery to the edge of the umbilical callus, becoming much less pronounced as they recede from the basal lip of the aperture. The type measures: maximum diameter, 3.5 mm.; height, 1.6 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 203-D-1, near Port Parker, Costa Rica, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., dredged in 15 fathoms (27 meters), sandy mud, crushed shell. Additional specimens were dredged at Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., in 12 fathoms (22 meters), shelly mud.

It is possible that the shell described as *Ethalia pyricallosa* by Carpenter[142] may have been described from the young of this

[140] *Teinostoma percarinatum* Pilsbry & Olsson, *Proc. Acad. Nat. Sci. Philadelphia*, Vol. 97, December 27, 1945, p. 252, pl. 23, figs. 6, 6a, 6b. Type locality, "Bayovar, Bay of Sechura, Peru." Also taken at Ancon Point, Ecuador.

[141] *Teinostoma (Pseudorotella) bibbiana* Dall, *Proc. U. S. Nat. Mus.*, Vol. 56, No. 2295, August 30, 1919, p. 369. "Type-locality—San Diego, California, Mrs. Oldroyd."

[142] *Ethalia pyricallosa* Carpenter, Cat. Mazatlan Shells, June, 1856, p. 251. "Hab.-Mazatlan; 1 sp. off Spondylus; L'pool Col."

pecies, the shape changing with age. Howver none of the paratypes have measurenents agreeing with those given by Carenter.

The shell of the species here described as ew resembles that of *Anticlimax* (*Sublimax*) *tholus* Pilsbry & McGinty[143] from Florida but is less carinate and somewhat nore depressed in outline. *Anticlimax* (*Subclimax*) *tholus prodromus* Pilsbry & Olsson [144], described from the Pliocene of Florida, possesses a more strongly carinated shell than that of *A. tholus*.

This species is named for the late George Willett whose careful work added much to the knowledge of West American mollusks.

Superfamily Zygobranchia.

FAMILY FISSURELLIDAE.

Genus **Fissurella** Bruguière.

Fissurella beebei

Hertlein & Strong, sp. nov.

Plate X, Figs. 3, 4, 5.

Shell ovately oblong, thin, conical, moderately elevated; orifice large, ovate, slightly anterior to the center; sculptured with numerous fine, regular, alternating larger and smaller radiating ribs which are crossed by concentric threads giving rise to a finely cancellated or beaded appearance; color yellowish-gray crossed by about 8 major radiating brownish-black rays of varying width; interior margin finely crenulated; color of interior white. Length, 41.2 mm.; width, 28 mm.; height, 12.1 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from station 150-D-3, Gorda Banks, Gulf of California, Lat. 23° 00′ 00″ N., Long. 109° 28′ 00″ W., dredged in 58 fathoms (106 meters), sand. Paratype from the same vicinity at Station 150-D-5, in 40-100 fathoms (73-182 meters), sand. Collected by the Templeton Crocker Expedition to the Gulf of California, 1936.

The sculpture of the paratype is considerably coarser than that on the holotype. This is believed to be due to individual variation and not specific because in the other characters they agree very well.

This new species bears some resemblance to *Fissurella oriens* Sowerby[145] described from Chile, but in the present form the orifice is evenly and widely oval and the sides are not excavated in the middle, also the radial sculpture appears to be finer and is evenly cancellated.

The characters of the orifice already enumerated, the proportionately wider shape of the shell, as well as the lack of a conspicuous white border around the orifice exteriorly, are features separating this new species from *Fissurella mexicana* Sowerby[146].

This species is named for Dr. William Beebe, director of the expedition during the course of which the type specimens of this species were collected.

Genus **Hemitoma** Swainson.

Hemitoma chiquita

Hertlein & Strong, sp. nov.

Plate X, Figs. 2, 7, 10.

Shell small, thin, ovately oblong, moderately elevated, narrower anteriorly; apex situated somewhat anteriorly and curved toward the posterior; shell sloping from the apex, slightly excavated posteriorly below the apex; sinus small, situated between 2 posterior ribs; sculptured with rather coarse, radial ribs of which the alternating ones are coarser, about 7 or 8 are considerably coarser than the others and posteriorly these are double, the radial ribs are crossed by concentric lines of growth giving a somewhat nodulous appearance; yellowish-white, a fresh specimen light horn-colored. Measurements of the type: greater diameter, 5 mm.; lesser diameter, 3.7 mm.; height, 1.6 mm.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 195-D-9, Port Guatulco, Mexico, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., dredged in 7 fathoms (12.6 meters), in gr. sand and crushed shell. One additional small specimen was taken at the same locality.

This new species differs from *Hemitoma bella* Gabb[147], described from Monterey, California, in that the apex is more anteriorly situated, it has much stronger alternate ribbing and the anterior ribs are much coarser in comparison to those on the species described by Gabb.

Compared to *Hemitoma hermosa* Lowe[148], described from Carmen Island in the Gulf of California, the shell of this new species is less elevated, less rugose, the sides slope more gently from the apex and the ribbing is finer. Lowe's species bears a general resemblance to *Hematoma sclera* Woodring which was described from the Bowden Mio-

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143 *Climacia tholus* Pilsbry & McGinty, *Nautilus*, Vol. 59, No. 3, January, 1946, p. 79, pl. 8, figs. 1, 1a, 1b, 2, 2a. "About four miles off Carysfort Light, Florida, in about 500 ft."

144 *Anticlimax tholus prodromus* Pilsbry & Olsson, *Bull. Amer. Paleo.*, Vol. 33, No. 135, July 5, 1950, p. 113 (11), pl. 20 (4), figs. 13, 13a, 14. "Pliocene: Alligator Creek, Acline, Florida."

145 *Fissurella oriens* Sowerby, *Proc. Zool. Soc. London* for 1834, p. 124 (issued March 20, 1835). "Hab. ad Insulam Chiloe sub lapidibus littoralibus."—Sowerby, Conch. Illustr., *Fissurella*, Cat., p. 3, issued June 30, 1835, pl. 71, fig. 25, December 21, 1831 [misprint for 1834 ac- cording to Sherborn]. "Island of Chiloe, Mr. Cuming."— Reeve, Conch. Icon., Vol. 6, *Fissurella*, 1849, species 13, pl. 2, fig. 13. "Hab. Valparaiso (attached to rocks); Cuming."

146 *Fissurella mexicana* Sowerby, Conch. Illustr., *Fissurella*, Cat. p. 8, issued June 30, 1835, pl. 77, fig. 61, issued between January, 1835, and May 25, 1835. "Real Llejos, Mexico; Mr. Cuming." [Nicaragua].—Reeve, Conch. Icon., Vol. 6, *Fissurella*, 1849, species 40, pl. 6, fig. 40. Original locality cited.—Melvill & Standen, *Jour. Conch.*, Vol. 9, No. 4, 1898, p. 102.

147 *Emarginula bella* Gabb, *Proc. Calif. Acad. Nat. Sci.*, Vol. 3, January, 1865, p. 188. "Locality Monterey, Dr. Cooper. 'Two dredged dead'."—Smith & Gordon, *Proc. Calif. Acad. Sci.* Ser. 4, Vol. 26, No. 8, 1948, p. 204, pl. 4, figs. 14, 15, 16 (as *Hemitoma bella*).

148 *Hemitoma hermosa* Lowe, *Trans. San Diego Soc. Nat. Hist.*, Vol. 8, No. 6, March 21, 1935, p. 24, pl. 4, fig. 4. "Carmen Island, Gulf of California, 20 fathoms (1932). Type 11385, Lowe Collection."

cene of Jamaica. The finer ribbing, more acutely pointed spire, and thinner and flatter margins of *Hemitoma chiquita* are features which serve to separate it from *H. scrippsae* Durham[149] which was described from the Pliocene of Carmen Island in the Gulf of California.

Subclass Amphineura.

ORDER POLYPLACOPHORA.

Superfamily Mesoplacophora.

FAMILY ISCHNOCHITONIDAE.

Genus **Ischnochiton** Gray.

By George Willett.

Ischnochiton crockeri Willett, sp. nov.

Plate XI, Fig. 12.

Description: Shell rather small, elongate-oval, elevated; dorsal ridge thin, side slopes well rounded. Entire surface finely pustulate.

Anterior valve with about 30 radiating series of rounded pustules, 15-20 in a series, these occasionally bifurcating near the anterior margin; posterior margin irregularly pustulate but not dentate.

Median valves: lateral areas prominent, with 6-8 rows of pustulate ribs, and irregular indication of dentation on the posterior margins. Central areas on each side with 22-25 thin, longitudinal ribs, the lower ones inclining sharply downward, and those on the dorsal area being horizontal excepting on the second valve; on this valve they are widely-spaced anteriorly and converge posteriorly. These ribs are connected by frequent, low, delicate riblets which, on the posterior part of the dorsal region, are obliterated by the surface pustulation.

Posterior valve convex above the low mucro, concave below it. The part of the valve anterior to the mucro is sculptured like the central areas of the median valves; the posterior part has about 27 radiating rows of pustules, which are fairly clear excepting immediately beneath the mucro, where they are absent.

Girdle about 2 millimeters in width, clothed with small, oval, imbricating scales, which are somewhat rounded on top. These scales appear smooth to the naked eye, but under sufficient magnification they show 15-20 fine cross striations. Color of outer surface brown, irregularly flecked with olive, the jugal region being clouded with reddish-brown, and some pustules on lateral areas and end valves being whitish. Girdle cream-colored, mottled with reddish-brown and irregularly spotted with black.

Holotype (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Station 150-D-6, Gorda Banks in the Gulf of California off the southern end of Lower California, Lat. 23° 02′ 00″ N., Long. 109° 31′ 00″ W., dredged in 60 fathoms (109 meters), rocks, muddy sand. Dimensions of type (exclusive of girdle): length, 18.4 mm.; diameter, 9.6 mm.; altitude, 4 mm.

Remarks: At a cursory glance this chiton, excepting for its larger size, appears much like *Ischnochiton decipiens* Carpenter[150]. However, a careful examination reveals that it differs from that species in more (6-8) rows of pustules on the lateral areas, and more (22-25) transverse ribs on the central areas. The scales on the girdle are also very different. In *I. decipiens* these are crossed by 6-8 coarse striations, easily visible under magnification of 10 diameters; in *I. crockeri* the scales appear smooth under the latter magnification, but when enlarged 25 times they show 15-20 very fine striations.

This species is named for the late Templeton Crocker, owner of the yacht *Zaca*, who collected assiduously during the expedition during which the type specimen of this species was taken.

EXPLANATION OF THE PLATES.*

PLATE I.

Fig. 1. *Kylix turveri* Hertlein & Strong, sp. nov. Holotype, from Station 142-D-2, Lat. 27° 04′ 00″ N., Long. 111° 55′ 00″ W., Santa Inez Bay, Gulf of California, dredged in 30-35 fathoms (54-64 meters). Length, 19.3 mm.; maximum diameter, 7.4 mm. P. 76.

Fig. 2. *Elaeocyma craneana* Hertlein & Strong, sp. nov. Holotype, from Bahia Honda, Panama. Length, 21 mm.; maximum diameter, 8 mm. P. 75.

Fig. 3. *Crassispira xanti* Hertlein & Strong, sp. nov. Holotype, from Station 135, San Lucas Bay, Lower California. Length, 15.5 mm.; maximum diameter, 5.8 mm. P. 74.

Fig. 4. *Cymatosyrinx asaedai* Hertlein & Strong, sp. nov. Holotype, from Station 136-D-2, Lat. 23° 30′ 30″ N., Long. 109° 26′ 00″ W., Arena Bank, Gulf of California, dredged in 45 fathoms (82 meters). Length, 27 mm.; maximum diameter, 9.8 mm. P. 78.

Fig. 5. *Kylix zacae* Hertlein & Strong, sp. nov. Holotype, from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W. off San Domingo Point, Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters). Length, 14.5 mm.; maximum diameter, 5.0 mm. P. 76.

Fig. 6. *Cytharella burchi* Hertlein & Strong, sp. nov. Holotype, from Station 136-D-22, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., Arena Bank, Gulf of California, dredged in 45 fathoms (82 meters). Length, 16.5 mm.; maximum diameter, 6.3 mm. P. 79.

Fig. 7. *Cymatosyrinx allyniana* Hertlein & Strong, sp. nov. Holotype, from Station 136-D-4, Lat. 23° 32′ 00″ N., Long. 109°

[149] *Hemitoma scrippsae* Durham, *Geol. Soc. Amer., Mem.* 43, Pt. 2, August 10, 1950, p. 133, pl. 28, figs. 9, 14.

[150] *I[schnochiton]. decipiens* Carpenter in Pilsbry, Man. Conch., Vol. 14, November 25, 1892, p. 123. "Monterey, California."

* The cost of preparing photographs of the specimens used for illustrations on the plates in this paper was defrayed by a grant-in-aid to the senior author by the American Philosophical Society. The photographs were made by Frank L. Rogers.

27′ 00″ W., dredged in 55 fathoms (100 meters). Length, 20.7 mm.; maximum diameter, 8.2 mm. P. 77.

Fig. 8. *Clathurella erminiana* Hertlein & Strong, sp. nov. Holotype, from Station 147-D-2, Lat. 26° 57′ 30″ N., Long. 111° 48′ 30″ W., off Concepcion Point, Santa Inez Bay, Gulf of California, dredged in 60 fathoms (110 meters). Length, 12.5 mm.; maximum diameter 5.0 mm. P. 71.

Fig. 9. *Strombinoturris crockeri* Hertlein & Strong, sp. nov. Holotype, from Station 136-D-24, Lat. 23° 29′ 00″ N., Long. 109° 23′ 30″ W., Arena Bank, Gulf of California, dredged in 50 fathoms (91 meters). Length, 43.2 mm.; maximum diameter, 14.0 mm. P. 84

Fig. 10. *Carinodrillia pilsbryi* Lowe. Hypotype, from Station 136-D-14, Lat. 23° 29′ 30″ N., Long. 109° 25′ 00″ W., off Arena Point, Lower California, dredged in 45 fathoms (82 meters). Length, 34 mm.; maximum diameter, 11.5 mm. P. 71.

This specimen differs somewhat in color from the type of *Carinodrillia pilsbryi* but otherwise it is so similar that it is here assigned to that species.

Fig. 11. *Crassispira ericana* Hertlein & Strong, sp. nov. Holotype, from Santa Inez Bay, Gulf of California, from the same locality as that of the specimen shown in Fig. 5. Length, 11.5 mm.; maximum diameter, 4.3 mm. P. 74.

Fig. 12. *Crassispira chacei* Hertlein & Strong, sp. nov. Holotype, from Station 150-D-23, Lat. 23° 01′ 00″ N., Long. 109° 27′ 30″ W., Gorda Banks, Gulf of California, dredged in 45 fathoms (82 meters). Length, 29.5 mm.; diameter, 10.7 mm. P. 73.

Fig. 13. *Crassispira tangolaensis* Hertlein & Strong, sp. nov. Holotype, from Station 196-D-6, 7, Lat. 15° 45′ 34″ N., Long. 96° 06′ 02″ to 96° 06′ 03″ W., Tangola-Tangola Bay, Mexico, dredged in 6-7 fathoms (11-12.8 meters). Length, 14 mm.; maximum diameter, 5.4 mm. P. 75.

Fig. 14. *Cymatosyrinx strohbeeni* Hertlein & Strong, sp. nov. Holotype, dredged off Cape San Lucas, Lower California. Length, 11.5 mm.; maximum diameter, 3.5 mm. P. 77.

Fig. 15. *Crockerella pederseni* Hertlein & Strong, sp. nov. Holotype, from Santa Inez Bay, Gulf of California, same locality as that of the specimen shown in Fig. 5. Length, 4.8 mm.; maximum diameter, 1.9 mm. P. 78.

Fig. 16. *Crockerella hilli* Hertlein & Strong, sp. nov. Holotype, from Santa Inez Bay, Gulf of California, same locality as that of the specimen shown in Fig. 5. Length, 3.8 mm.; maximum diameter, 1.5 mm. P. 79.

Fig. 17. *Cymatosyrinx arenensis* Hertlein & Strong, sp. nov. Holotype, from Arena Bank, Gulf of California, same locality as that of the specimen shown in Fig. 6. Length, 45 mm.; maximum diameter, 14.5 mm. P. 76.

Fig. 18. *Crassispira brujae* Hertlein & Strong, sp. nov. Holotype, from Station 136-D-13, Lat. 23° 29′ 00″ N., Long. 109° 24′ 00″ W., Arena Bank, Gulf of California, dredged in 45 fathoms (82 meters). Length, 29 mm.; maximum diameter, 9.2 mm. P. 74.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

Plate II.

Fig. 1. *Trophon (Acanthotrophon) sorenseni* Hertlein & Strong, sp. nov. Holotype, from Station 150-D-24, Lat. 23° 01′ 00″ N., Long. 109° 29′ 00″ W., Gorda Banks, Gulf of California, dredged in 60 fathoms (109 meters). Length, 31 mm.; maximum diameter (not including spines), 14 mm. P. 86.

Fig. 2. *Calotrophon bristolae* Hertlein & Strong, sp. nov. Holotype, from Gorda Banks, from the same locality as the specimen shown in Fig. 1. Length, 39 mm.; maximum diameter, 20 mm. P. 87.

Fig. 3. *Anachis coronata hannana* Hertlein & Strong, sp. nov. Holotype, from Cape San Lucas, Lower California, Mexico. Length, 13.6 mm.; maximum diameter, 6.3 mm. P. 82.

Fig. 4. *Latirus hemphilli* Hertlein & Strong, sp. nov. Holotype, from Port Parker, Costa Rica. Length, 68.5 mm.; maximum diameter, 23.8 mm. P. 79.

Fig. 5. *Anachis teevani* Hertlein & Strong, sp. nov. Holotype, from Station 189-D-4, Lat. 16° 38′ 30″ N., Long. 99° 40′ 00″ W., 17 miles SE. × E. of Acapulco, Mexico, dredged in 28 fathoms (51 meters). Length, 8 mm.; diameter, 3.5 mm. P. 83.

Fig. 6. *Pseudoneptunea panamica* Hertlein & Strong, sp. nov. Paratype from Station 142-D-3, Lat. 27° 04′ 00″ N., Long. 111° 54′ 00″ W., Santa Inez Bay, Gulf of California, dredged in 40 fathoms (73 meters. Length, 29.6 mm.; diameter, 25 mm. P. 81.

Fig. 7. *Strombina marksi* Hertlein & Strong, sp. nov. Holotype, Station 136-D-4, Lat. 23° 32′ 00″ N., Long. 109° 27′ 00″ W., Arena Bank, Gulf of California, dredged in 55 fathoms (100 meters). Length, 23.8 mm.; maximum diameter, 9.5 mm. P. 84.

Fig. 8. *Pterynotus (Pteropurpura) swansoni* Hertlein & Strong, sp. nov. Holotype, from Station 136-D-22, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., Arena Bank, Gulf of California, dredged in 45 fathoms (82 meters). Length, 59 mm.; maximum diameter (including varices), 49 mm. P. 85.

Fig. 9. *Muricopsis zeteki* Hertlein & Strong, sp. nov. Holotype, from Panama City, Panama. Length, 27.3 mm.; maximum diameter, including spines, 18.5 mm. P. 85.

Fig. 10. *Pseudoneptunea panamica* Hertlein & Strong, sp. nov. Holotype, from Station 224, Lat. 7° 23′ 30″ N., Long. 82° 03′ 00″ W., Hannibal Bank, Panama, dredged in 35-40 fathoms (64-73 meters). Length, 39 mm.; maximum diameter, 25 mm. P. 81.

Fig. 11. *Anachis ritteri* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Length, 7.4 mm.; diameter, 3.8 mm. P. 82.

Fig. 12. *Pterynotus* (*Pteropurpura*) *swansoni* Hertlein & Strong, sp. nov. Apertural view of the specimen shown in Fig. 8.

Fig. 13. *Turritella clarionensis* Hertlein & Strong, sp. nov. Holotype, from Station 163-D-2, Lat. 18° 19′ 00″ N., Long. 114° 45′ 00″ W., 3 miles off Pyramid Rock, near Clarion Island, Revillagigedo Islands, Mexico, dredged in 55 fathoms (100 meters). Length, 56 mm.; maximum diameter, 16.5 mm. P. 108.

Fig. 14. *Anachis rehderi* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Length, 8.5 mm.; diameter, 3.3 mm. P. 83.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

PLATE III.

Fig. 1. *Epitonium* (*Cirsotrema*) *togatum* Hertlein & Strong, sp. nov. Holotype, from Station 150-D-19, Lat. 23° 01′ 00″ N., Long. 109° 27′ 30″ W., Gorda Banks, Gulf of California, dredged in 50 fathoms (91 meters). Length, 37.5 mm.; maximum diameter (including the varices), 13.8 mm. P. 89.

Fig. 2. *Turbonilla* (*Pyrgiscus*) *biolleyi* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Length, 3.6 mm.; diameter, 0.9 mm. P. 98.

Fig. 3. *Turbonilla* (*Pyrgiscus*) *zacae* Hertlein & Strong, sp. nov. Holotype, from near Port Parker, Costa Rica, from the same locality as the specimen shown in Fig. 2. Length, 5.7 mm.; diameter, 1.4 mm. P. 95.

Fig. 4. *Turbonilla* (*Pyrgiscus*) *nicoyana* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, near Port Parker, Costa Rica, from the same locality as the specimen shown in Fig. 2. Length, 4.0 mm.; diameter, 1.1 mm. P. 96.

Fig. 5. *Epitonium* (*Cirsotrema*) *togatum* Hertlein & Strong, sp. nov. Paratype, from Station 214-D-1-4, Lat. 9° 19′ 32″ to 9° 17′ 40″ N., Long. 84° 29′ 30″ to 84° 27′ 30″ W., 14 miles S. × E. of Judas Point, Costa Rica, dredged in 42-61 fathoms (76.5-112 meters). Length, 33.4 mm.; diameter (including varices), 11.2 mm. P. 89.

Fig. 6. *Rissoina axeliana* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Length, 2.4 mm.; diameter, 1.0 mm. P. 109.

Fig. 7. *Epitonium* (*Sthenorytis*) *paradisi* Hertlein & Strong, sp. nov. Holotype, from Station 150-D-13, Lat. 23° 01′ 00″ N., Long. 109° 27′ 30″ W., Gorda Banks, Gulf of California, dredged in 70-80 fathoms (128-146 meters). Length, 35 mm.; maximum diameter (including varicose ribs), 26.5 mm. P. 90.

Fig. 8. *Odostomia* (*Chrysallida*) *woodbridgei* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters). Length, 2.3 mm.; diameter, 0.9 mm. P. 103.

Fig. 9. *Epitonium* (*Nitidiscala*) *durhamianum* Hertlein & Strong, sp. nov. Holotype, from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters). Length, 5.7 mm.; diameter, 1.8 mm. P. 89.

Fig. 10. *Epitonium* (*Nitidiscala*) *oerstedianum* Hertlein & Strong, sp. nov. Holotype, from Station 145-D-1-3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters). Length, 6.5 mm.; diameter, 4.2 mm. P. 89.

Fig. 11. *Epitonium* (*Asperiscala*) *vivesi* Hertlein & Strong, sp. nov. Holotype, from Santa Inez Bay, Gulf of California, from the same locality as the specimen illustrated in Fig. 10. Length, 7.0 mm.; diameter, 3.2 mm. P. 88.

Fig. 12. *Epitonium* (*Asperiscala*) *walkerianum* Hertlein & Strong, sp. nov. Holotype, from near Corinto, Nicaragua, from the same locality as the specimen shown in Fig. 9. Length, 3.7 mm.; diameter, 1.2 mm. P. 88.

Fig. 13. *Epitonium* (*Asperiscala*) *manzanillense* Hertlein & Strong, sp. nov. Holotype, from Station 184-D-2, Lat. 19° 04′ 00″ N., Long. 104° 22′ 00″ W., near Manzanillo, Mexico, dredged in 30 fathoms (55 meters). Length, 3.7 mm.; diameter, 1.4 mm. P. 88.

Fig. 14. *Epitonium* (*Punctiscala?*) *colimanum* Hertlein & Strong, sp. nov. Holotype, from near Manzanillo, Mexico, from the same locality as the specimen shown in Fig. 13. Length, 7.6 mm.; diameter, 2.8 mm. P. 90.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

PLATE IV.

Fig. 1. *Turbonilla* (*Strioturbonilla*) *corintonis* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 5.2 mm.; maximum diameter, 1.3 mm. P. 101.

Fig. 2. *Turbonilla* (*Pyrgolampros*) *soniliana* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Length, 5.8 mm.; diameter, 1.7 mm. P. 100.

Fig. 3. *Turbonilla* (*Pyrgiscus*) *gruberi* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 6.1 mm.; maximum diameter, 1.4 mm. P. 100.

Fig. 4. *Turbonilla* (*Strioturbonilla*) *masayana* Hertlein & Strong, sp. nov. Holotype,

from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters). Length, 3.4 mm.; maximum diameter, 1.0 mm. P. 101.

Fig. 5. *Turbonilla* (*Pyrgiscus*) *ottomoerchi* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 6.0 mm.; maximum diameter, 1.4 mm. P. 99.

Fig. 6. *Turbonilla* (*Pyrgolampros*) *meanguerensis* Hertlein & Strong, sp. nov. Holotype, from Station 199-D-1, Lat. 13° 08′ 00″ N., Long. 87° 43′ 00″ W., Meanguera Island, Gulf of Fonseca, El Salvador, dredged in 16 fathoms (29 meters). Length, 5.6 mm.; maximum diameter, 1.4 mm. P. 100.

Fig. 7. *Turbonilla* (*Strioturbonilla*) *nicaraguana* Hertlein & Strong, sp. nov. Holotype, from near Corinto, Nicaragua, from the same locality as that of the specimen shown in Fig. 4. Length, 4.5 mm.; maximum diameter, 1.2 mm. P. 102.

Fig. 8. *Turbonilla* (*Pyrgiscus*) *ekidana* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters). Length, 4.8 mm.; maximum diameter, 1.2 mm. P. 99.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

Plate V.

Fig. 1. *Turbonilla* (*Pyrgiscus*) *gordoniana* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 6.0 mm.; maximum diameter, 1.4 mm. P. 99.

Fig. 2. *Turbonilla* (*Cingulina*) *realejoensis* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 2.7 mm.; maximum diameter, 1.0 mm. P. 92.

Fig. 3. *Turbonilla* (*Pyrgiscus*) *chinandegana* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 4.8 mm.; maximum diameter, 0.9 mm. P. 97.

Fig. 4. *Turbonilla* (*Pyrgiscus*) *otnirocensis* Hertlein & Strong, sp. nov. Holotype, from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters). Length, 4.2 mm.; maximum diameter, 0.9 mm. P. 96.

Fig. 5. *Turbonilla* (*Pyrgiscus*) *cholutecana* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 4.1 mm.; maximum diameter, 0.7 mm. P. 97.

Fig. 6. *Turbonilla* (*Pyrgisculus*) *utuana* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters). Length, 3.1 mm.; diameter, 0.9 mm. P. 93.

Fig. 7. *Turbonilla* (*Pyrgiscus*) *tehuantepecana* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Length, 2.8 mm.; maximum diameter, 0.8 mm. P. 99.

Fig. 8. *Turbonilla* (*Pyrgisculus*) *utuana* Hertlein & Strong, sp. nov. Paratype, from Station 203-D-1, near Port Parker, Costa Rica, from the same locality as the specimen shown in Fig. 6. Length, 1.46 mm.; diameter, .703 mm. P. 93.

Fig. 9. *Turbonilla* (*Strioturbonilla*) *oaxacana* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same station as the specimen shown in Fig. 7. Length, 3.5 mm.; maximum diameter, 1.1 mm. P. 101.

Fig. 10. *Turbonilla* (*Pyrgiscus*) *ulyssi* Hertlein & Strong, sp. nov. Holotype, from near Corinto, Nicaragua, from the same station as the specimen shown in Fig. 4. Length, 5.0 mm.; diameter, 1.7 mm. P. 96.

Fig. 11. *Turbonilla* (*Pyrgiscus*) *guanacastensis* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Length, 4.3 mm.; diameter, 0.9 mm. P. 97.

Fig. 12. *Turbonilla* (*Pyrgiscus*) *rhizophorae* Hertlein & Strong, sp. nov. Holotype, from near Corinto, Nicaragua, from the same locality as the specimen in Fig. 4. Length, 3.4 mm.; diameter, 1.0 mm. P. 98.

Fig. 13. *Turbonilla* (*Strioturbonilla*) *contrerasiana* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen shown in Fig. 7. Length, 3.4 mm.; diameter, 0.9 mm. P. 102.

Fig. 14. *Turbonilla* (*Strioturbonilla*) *nahuatliana* Hertlein & Strong, sp. nov. Holotype, from near Corinto, Nicaragua, from the same locality as the specimen shown in Fig. 4. Length, 2.8 mm.; diameter, 0.9 mm. P. 101.

Fig. 15. *Turbonilla* (*Pyrgiscus*) *ozanneana* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 3.9 mm.; diameter, 1.0 mm. P. 98.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

Plate VI.

Fig. 1. *Balcis* (*Balcis*) *corintonis* Hertlein & Strong, sp. nov. Holotype, from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters). Length, 1.9 mm.; diameter, 0.7 mm. P. 90.

Fig. 2. *Balcis* (*Vitreolina*) *drangai* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Length, 3.3 mm.; diameter, 1.2 mm. P. 91.

Fig. 3. *Turbonilla* (*Careliopsis*) *beltiana* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 3.2 mm.; diameter, 0.9 mm. P. 91.

Fig. 4. *Turbonilla (Bartschella) vestae* Hertlein & Strong, sp. nov. Holotype, from near Corinto, Nicaragua, from the same locality as the specimen shown in Fig. 1. Length, 3.1 mm.; diameter, 1.0 mm. P. 91.

Fig. 5. *Turbonilla (Pyrgiscus) colimana* Hertlein & Strong, sp. nov. Holotype, from Station 184-D-2, Lat. 19° 04′ 00″ N., Long. 104° 22′ 00″ W., near Manzanillo, Mexico, dredged in 30 fathoms (55 meters). Length, 3.0 mm.; diameter, 0.9 mm. P. 94.

Fig. 6. *Turbonilla (Pyrgiscus) domingana* Hertlein & Strong, sp. nov. Holotype, from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters). Length, 6.3 mm.; diameter, 1.5 mm. P. 93.

Fig. 7. *Turbonilla (Pyrgiscus) amiriana* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Length, 5.8 mm.; diameter, 2.0 mm. P. 94.

Fig. 8. *Turbonilla (Chemnitzia) nicarasana* Hertlein & Strong, sp. nov. Holotype, from near Corinto, Nicaragua, from the same locality as the specimen shown in Fig. 1. Length, 5.2 mm.; diameter, 1.2 mm. P. 92.

Fig. 9. *Turbonilla (Mormula) guatulcoensis* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen shown in Fig. 2. Length, 5.9 mm.; diameter, 1.9 mm. P. 92.

Fig. 10. *Turbonilla (Ptycheulimella) portoparkerensis* Hertlein & Strong, sp. nov. Holotype, from near Port Parker, Costa Rica, from the same locality as the specimen shown in Fig. 7. Length, 7.3 mm.; diameter, 1.4 mm. P. 92.

Fig. 11. *Turbonilla (Pyrgiscus) templetonis* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters). Length, 4.3 mm.; diameter, 1.0 mm. P. 95.

Fig. 12. *Turbonilla (Pyrgiscus) sulacana* Hertlein & Strong, sp. nov. Holotype, from near Port Parker, Costa Rica, from the same locality as the specimen shown in Fig. 7. Length, 5.0 mm.; diameter, 1.1 mm. P. 95.

Fig. 13. *Turbonilla (Pyrgiscus) yolettae* Hertlein & Strong, sp. nov. Holotype, from off San Domingo Point, Santa Inez Bay, Gulf of California, from the same locality as the specimen shown in Fig. 6. Length, 4.1 mm.; diameter, 1.1 mm. P. 94.

Fig. 14. *Turbonilla (Pyrgiscus) ayamana* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, near Port Parker, Costa Rica, from the same locality as the specimen shown in Fig. 11. Length, 5.6 mm.; diameter, 1.3 mm. P. 96.

Fig. 15. *Turbonilla (Pyrgiscus) vivesi* Hertlein & Strong, sp. nov. Holotype, from off San Domingo Point, Santa Inez Bay, Gulf of California, from the same locality as the specimen shown in Fig. 6. Length, 6.8 mm.; diameter, 1.6 mm. P. 93.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

PLATE VII.

Fig. 1. *Odostomia (Miralda) rhizophorae* Hertlein & Strong, sp. nov. Holotype, from Station 200-D-19, Lat. 12° 28′ 03″ N., Long. 87° 12′ 39″ W., near Corinto, Nicaragua, dredged in 12-13 fathoms (22-24 meters). Length, 2.1 mm.; diameter, 1.9 mm. P. 105.

Fig. 2. *Odostomia (Chrysallida) guatulcoensis* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Length, 2.0 mm.; diameter, 1.0 mm. P. 103.

Fig. 3. *Odostomia (Besla) caneloensis* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters). Length, 1.6 mm.; diameter, 0.5 mm. P. 102.

Fig. 4. *Cerithiopsis oaxacana* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen shown in Fig. 2. Length, 2.6 mm.; diameter, 0.9 mm. P. 107.

Fig. 5. *Cerithiopsis perrini* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen shown in Fig. 2. Length, 1.9 mm.; diameter, 0.8 mm. P. 106.

Fig. 6. *Alvania? ingrami* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen shown in Fig. 2. Length, 3.1 mm.; diameter, 1.7 mm. P. 108.

Fig. 7. *Cerithiopsis guatulcoensis* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen shown in Fig. 2. Length, 3.7 mm.; diameter, 1.0 mm. P. 106.

Fig. 8. *Bittium (Lirobittium) arenaense* Hertlein & Strong, sp. nov. Holotype, from Station 136-D-22, Lat. 23° 28′ 30″ N., Long. 109° 25′ 00″ W., Arena Bank, Gulf of California, dredged in 45 fathoms (82 meters). Length, 10.5 mm.; diameter, 2.8 mm. P. 107.

Fig. 9. *Odostomia (Chrysallida) costaricensis* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Length, 2.9 mm.; diameter, 0.8 mm. P. 103.

Fig. 10. *Cerithiopsis guanacastensis* Hertlein & Strong, sp. nov. Holotype, from Long Beach NW. of Port Parker, Costa Rica. Length, 6.2 mm.; diameter, 2.0 mm. P. 106.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

PLATE VIII.

g. 1. *Odostomia (Evalea) gallegosiana* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Length, 2.8 mm.; diameter, 1.1 mm. P. 104.

g. 2. *Atys (Aliculastrum) liriope* Hertlein & Strong, sp. nov. Holotype, probably from Station 136-D-27, Lat. 23° 28′ 00″ N., Long. 109° 24′ 00″ W., Arena Bank, Gulf of California, dredged in 50 fathoms (91 meters). Length, 9.8 mm.; maximum diameter, 3.6 mm. P. 71.

g. 3. *Odostomia (Menestho) nicoyana* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters. Length, 3.3. mm.; diameter, 1.7 mm. P. 105.

ig. 4. *Fusiturricula armilda* Dall. Hypotype, from Station 136-D-23, Lat. 23° 28′ 00″ N., Long. 100° 24′ 00″ W., Arena Bank, Gulf of California, dredged in 40 fathoms (73 meters). Length, 40.3 mm.; diameter, 14 mm. P. 72.

ig. 5. *Odostomia (Telloda) subdotella* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters). Length, 2.9 mm.; diameter, 1.0 mm. P. 104.

ig. 6. *Nassarius insculptus gordanus* Hertlein & Strong, subsp. nov. Holotype, from Station 150-D-6, Lat. 23° 02′ 00″ N., Long. 109° 31′ 00″ W., Gorda Banks, Gulf of California, dredged in 60 fathoms (109 meters). Length, 22 mm.; diameter, 11.5 mm. P. 81.

ig. 7. *Odostomia (Evalina) tehuantepecana* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen illustrated in Fig. 1. Length, 2.3 mm.; diameter, 0.9 mm. P. 105.

'ig. 8. *Fusiturricula howelli* Hertlein & Strong, sp. nov. Holotype, from Station 214-D-1, 4, Lat. 9° 19′ 32″ to 9° 17′ 40″ N., Long. 84° 29′ 30″ to 84° 27′ 30″ W., 14 miles S. X E. of Judas Point, Costa Rica, dredged in 42-61 fathoms (76.5-112 meters). Length, 31 mm.; maximum diameter, 11 mm. P. 72.

'ig. 9. *Kurtzina cyrene* Dall. Hypotype, from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., off San Domingo Point, Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters). Length, 8.5 mm.; diameter, 3.4 mm. P. 78.

'ig. 10. *Rissoina (Folinia) ericana* Hertlein & Strong, sp. nov. Holotype, from near Port Guatulco, Mexico, from the same locality as the specimen shown in Fig. 1. Length, 3.0 mm.; diameter, 1.2 mm. P. 109.

'ig. 11. *Odostomia (Chrysallida) corintoensis* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Length, 4.0 mm.; diameter, 1.7 mm. P. 104.

'ig. 12. *Rissoina alarconi* Hertlein & Strong, sp. nov. Holotype, from near Port Parker, Costa Rica, from the same locality as the specimen shown in Fig. 3. Length, 4.8 mm.; diameter, 1.8 mm. P. 109.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

PLATE IX.

Fig. 1. *Scissilabra martensiana* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Maximum diameter, 1.5 mm.; height, 0.5 mm. P. 111.

Fig. 2. *Circulus bailyi* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Maximum diameter, 2.1 mm.; height, 0.9 mm. P. 111.

Fig. 3. *Cyclostrema gordana* Hertlein & Strong, sp. nov. Holotype, from Station 150-D-8, Lat. 23° 05′ 00″ N., Long. 109° 30′ 00″ W., Gorda Banks, Gulf of California, dredged in 40-45 fathoms (73-82 meters). Maximum diameter, 9.7 mm.; minimum diameter, 7.0 mm.; height, 3.3 mm. P. 110.

Fig. 4. *Cyclostrema gordana* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 3 and 7.

Fig. 5. *Scissilabra martensiana* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 1 and 10.

Fig. 6. *Circulus bailyi* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 2 and 9.

Fig. 7. *Cyclostrema gordana* Hertlein & Strong, sp. nov. Basal view of specimen shown in Figs. 3 and 4.

Fig. 8. *Teinostoma herbertiana* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Maximum diameter, 1.5 mm.; height, 0.7 mm. View of base. What appears to be an open umbilicus in this figure is actually due to refraction of light on the callus pad covering the umbilical opening. P. 112.

Fig. 9. *Circulus bailyi* Hertlein & Strong, sp. nov. Basal view of specimen shown in Figs. 2 and 6.

Fig. 10. *Scissilabra martensiana* Hertlein & Strong, sp. nov. Basal view of specimen shown in Figs. 1 and 5.

Fig. 11. *Teinostoma herbertiana* Hertlein & Strong, sp. nov. Apertural view of specimen shown in Figs. 8 and 12.

Fig. 12. *Teinostoma herbertiana* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 8 and 11.

Fig. 13. *Anticlimax (Subclimax) willetti* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-1, Lat. 10° 56′ 05″ N., Long. 85° 49′ 25″ W., near Port Parker, Costa Rica, dredged in 15 fathoms (27 meters). Maximum diameter, 3.5 mm.; height, 1.6 mm. P. 112.

Fig. 14. *Anticlimax (Subclimax) willetti* Hertlein & Strong, sp. nov. Apertural view of specimen shown in Figs. 13 and 15.

Fig. 15. *Anticlimax (Subclimax) willetti* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 13 and 14.

All the specimens illustrated on this plate are in the type collection of the

Department of Paleontology of the California Academy of Sciences.

PLATE X.

Fig. 1. *Cyclostremiscus humboldti* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Maximum diameter, 1.8 mm.; height, 1.5 mm. P. 110.

Fig. 2. *Hemitoma chiquita* Hertlein & Strong, sp. nov. Holotype, from Station 195-D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms (12.6 meters). Greater diameter, 5 mm.; lesser diameter, 3.7 mm.; height, 1.6 mm. P. 113.

Fig. 3. *Fissurella beebei* Hertlein & Strong, sp. nov. Holotype, from Station 150-D-3, Lat. 23° 00′ 00″ N., Long. 109° 28′ 00″ W., Gorda Banks, Gulf of California, dredged in 58 fathoms (106 meters). Length, 41.2 mm.; width, 28 mm.; height, 12.1 mm. P. 113.

Fig. 4. *Fissurella beebei* Hertlein & Strong, sp. nov. View of interior of specimen shown in Fig. 3.

Fig. 5. *Fissurella beebei* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 3 and 4.

Fig. 6. *Circulus taigai* Hertlein & Strong, sp. nov. Holotype, from Corinto, Nicaragua. Maximum diameter, 2.0 mm.; height, 1.0 mm. P. 111.

Fig. 7. *Hemitoma chiquita* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 2 and 10.

Fig. 8. *Circulus taigai* Hertlein & Strong, sp. nov. Apertural view of specimen shown in Figs. 6 and 9.

Fig. 9. *Circulus taigai* Hertlein & Strong, sp. nov. Basal view of specimen shown in Figs. 6 and 8.

Fig. 10. *Hemitoma chiquita* Hertlein & Strong, sp. nov.View of side of specimen shown in Figs. 2 and 7.

Fig. 11. *Teinostoma zacae* Hertlein & Strong, sp. nov. Holotype, from Station 203-D-3, Lat. 10° 55′ 45″ N., Long. 85° 49′ 05″ W., near Port Parker, Costa Rica, dredged in 12 fathoms (22 meters). Maximum diameter, 2.0 mm.; height, 1.1 mm. P. 112.

Fig. 12. *Teinostoma zacae* Hertlein & Strong, sp. nov. Apical view of specimen shown in Figs. 11 and 13.

Fig. 13. *Teinostoma zacae* Hertlein & Strong, sp. nov. Basal view of specimen shown in Figs. 11 and 12.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.

PLATE XI.

Fig. 1. *Cadulus* (*Platyschides*) *austinclarki* Emerson. Hypotype, from Station 145-D-1, 3, Lat. 26° 52′ 00″ N., Long. 111° 53′ 00″ W., Santa Inez Bay, Gulf of California, dredged in 4-13 fathoms (7.5-24 meters). Length, 4.05 mm.; diameter at aperture, 0.18 mm. P. 70.

Fig. 2. *Aesopus osborni* Hertlein & Strong, sp. nov. Holotype, from Station 195, D-9, Lat. 15° 44′ 28″ N., Long. 96° 07′ 51″ W., near Port Guatulco, Mexico, dredged in 7 fathoms, 12.6 meters). Length, 3.0 mm.; diameter, 1.0 mm. P. 83.

Fig. 3. *Latirus mediamericanus* Hertlein & Strong, sp. nov. Holotype, from Gorgona Island, Colombia. Length, 52.8 mm.; maximum diameter, 18 mm. P. 80.

Fig. 4. *Crassispira turricula ballenaensis* Hertlein & Strong, subsp. nov. Holotype, from Station 206-D-1, 3, Lat. 10° 37′ 03″ to 10° 36′ 22″ N., Long. 85° 41′ 08″ to 85° 41′ 12″ W., off Port Culebra, Costa Rica, dredged in 14 fathoms (25.5 meters). Length, 33.2 mm.; maximum diameter, 11 mm. P. 73.

Fig. 5. *Elaeocyma salvadorica* Hertlein & Strong, sp. nov. Holotype, from Station 198-D-1, Lat. 13° 27′ 20″ N., Long. 89° 19′ 20″ W., off La Libertad, El Salvador, dredged in 13 fathoms (24 meters). Length, 29 mm.; maximum diameter, 11 mm. P. 76.

Fig. 6. *Cadulus* (*Platyschides*) *austinclarki* Emerson. View showing slits in apex of specimen shown in Fig. 1.

Fig. 7. *Vanikoro galapagana* Hertlein & Strong, sp. nov. Holotype, from Station 54, *Arcturus* Expedition, Hood Island, Galapagos Islands. Height, 7.5 mm.; diameter, 13.5 mm. P. 110.

Fig. 8. *Vanikoro galapagana* Hertlein & Strong, sp. nov. Apical view of specimen shown in Fig. 7.

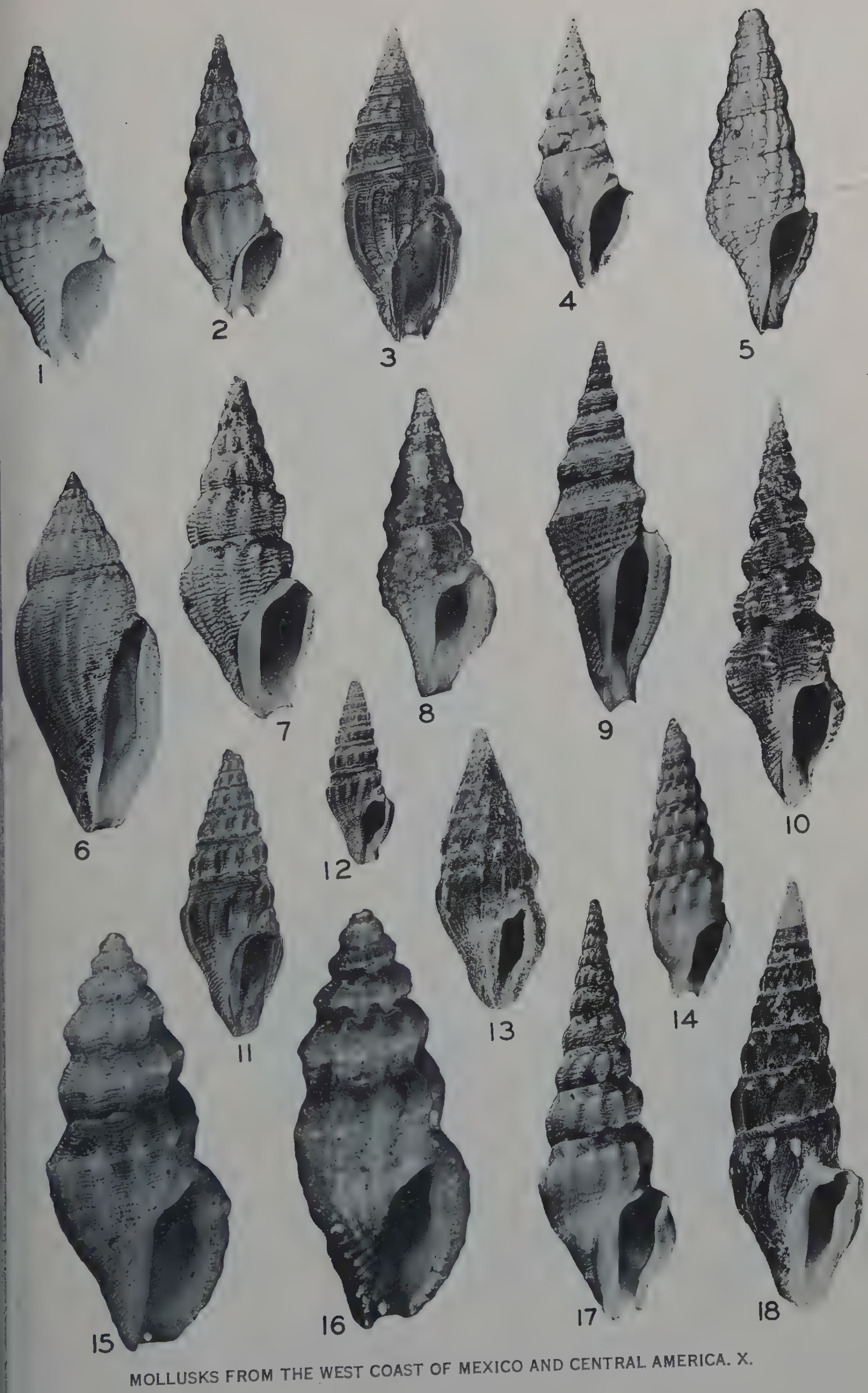
Fig. 9. *Dentalium* (*Rhabdus*) *cedrosense* Hertlein & Strong, sp. nov. Holotype, from Station 126-D-12, Lat. 28° 20′ 00″ N., Long. 115° 10′ 30″ W., a mile off east coast of Cedros Island, Lower California, Mexico, dredged in 45 fathoms (82 meters). Length, 9 mm.; diameter at aperture, .24 mm. P. 69.

Fig. 10. *Latirus mediamericanus* Hertlein & Strong, sp. nov. Paratype, from Pearl Islands, Bay of Panama. Length (incomplete), 58.3 mm.; diameter, 22 mm. P. 80.

Fig. 11. *Crassispira turricula ballenaensis* Hertlein & Strong, subsp. nov. Paratype, from Station 213-D-11, 17, Lat. 9° 44′ 52″ N., Long. 84° 51′ 25″ W., to Lat. 9° 42′ 00″ N., Long. 84° 56′ 00″ W., off Ballena Bay, Gulf of Nicoya, Costa Rica, in 35 fathoms (63.7 meters). Length, 37.4 mm.; maximum diameter, 11.5 mm. P. 73.

Fig. 12. *Ischnochiton crockeri* Willett, sp. nov. Holotype, from Station 150-D-6, Lat. 23° 02′ 00″ N., Long. 109° 31′ 00″ W., Gorda Banks, Gulf of California, dredged in 60 fathoms (109 meters). Length (exclusive of girdle), 18.4 mm.; diameter, 9.6 mm.; altitude, 4 mm. P. 114.

All the specimens illustrated on this plate are in the type collection of the Department of Paleontology of the California Academy of Sciences.



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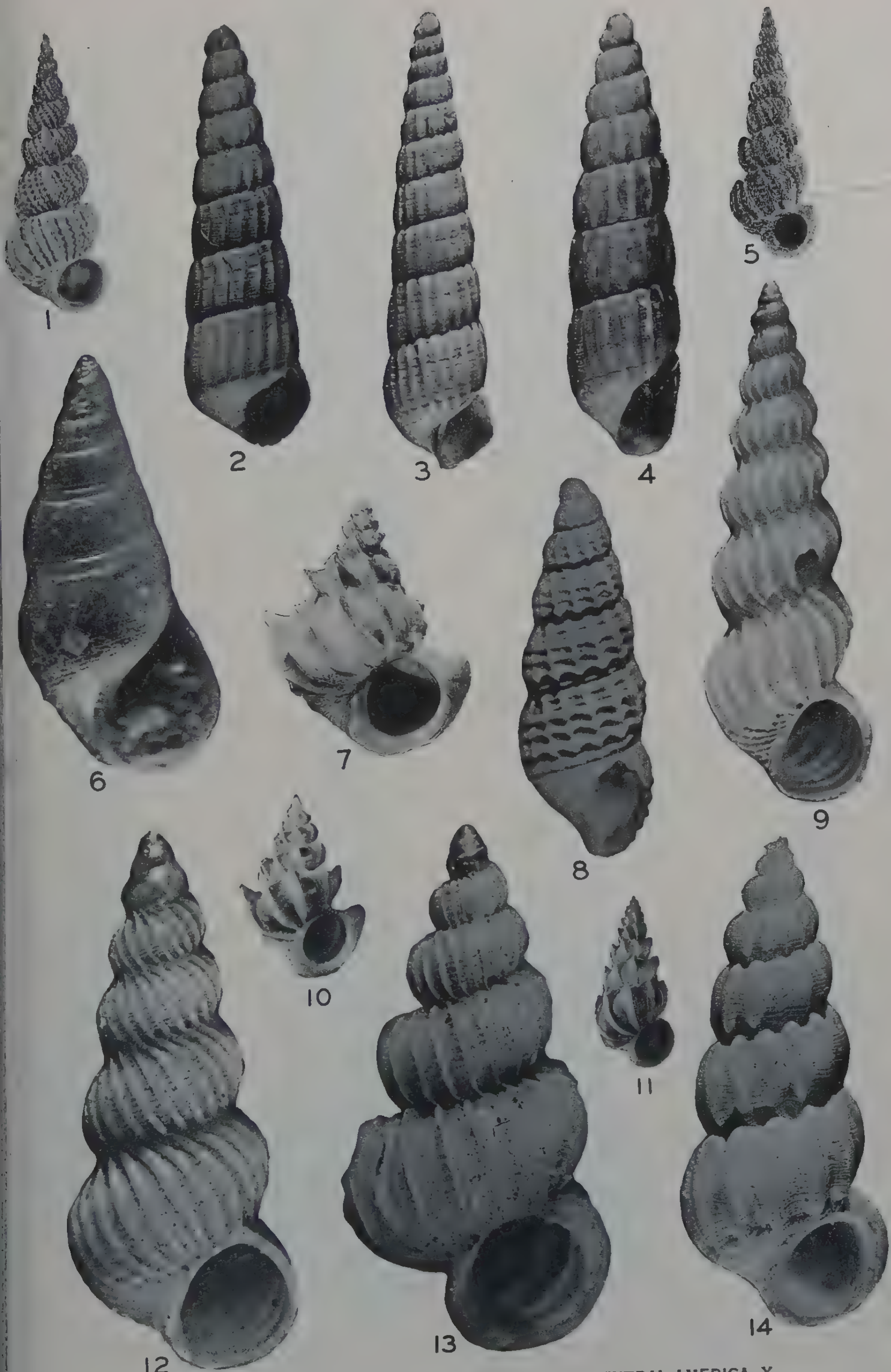

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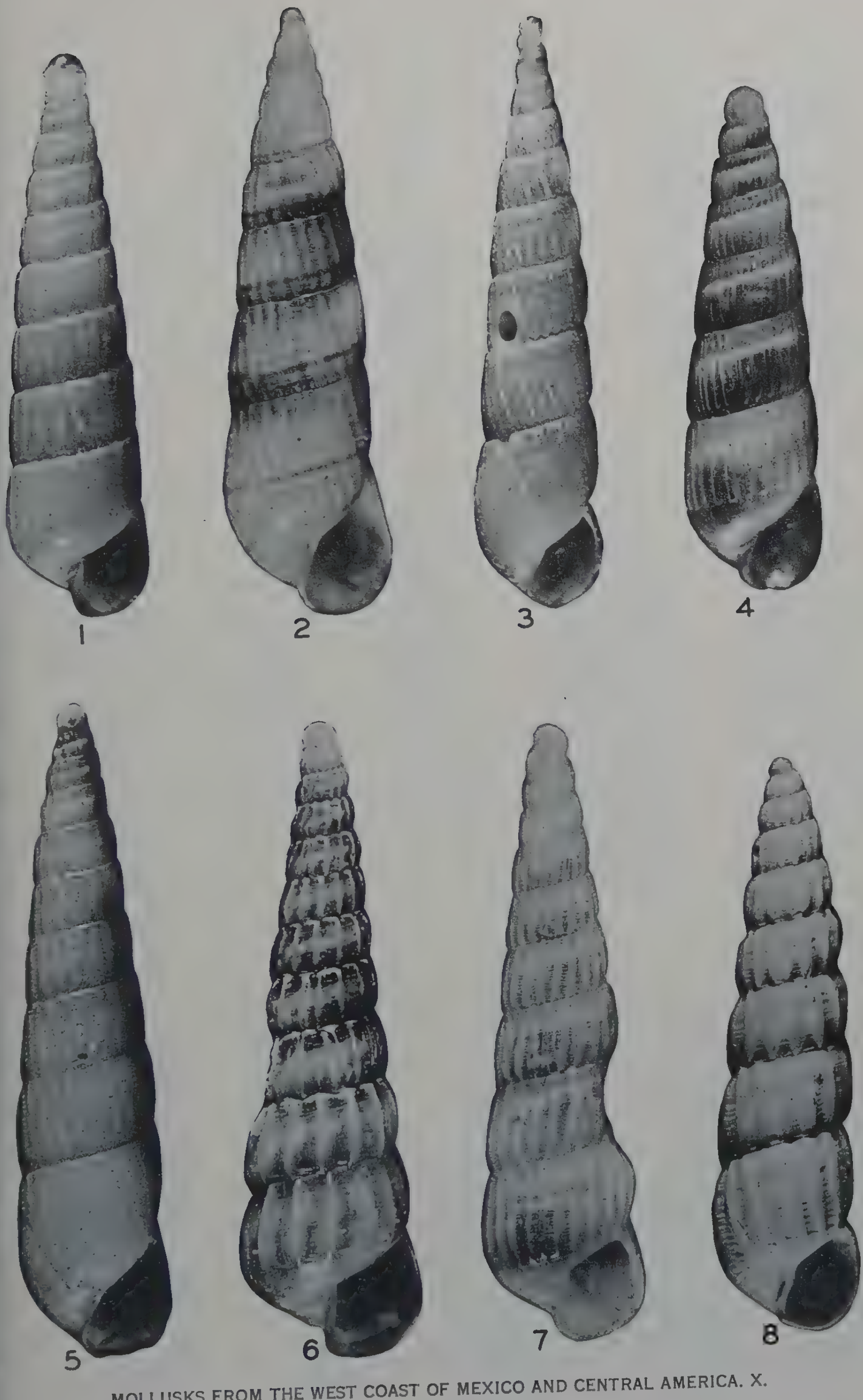

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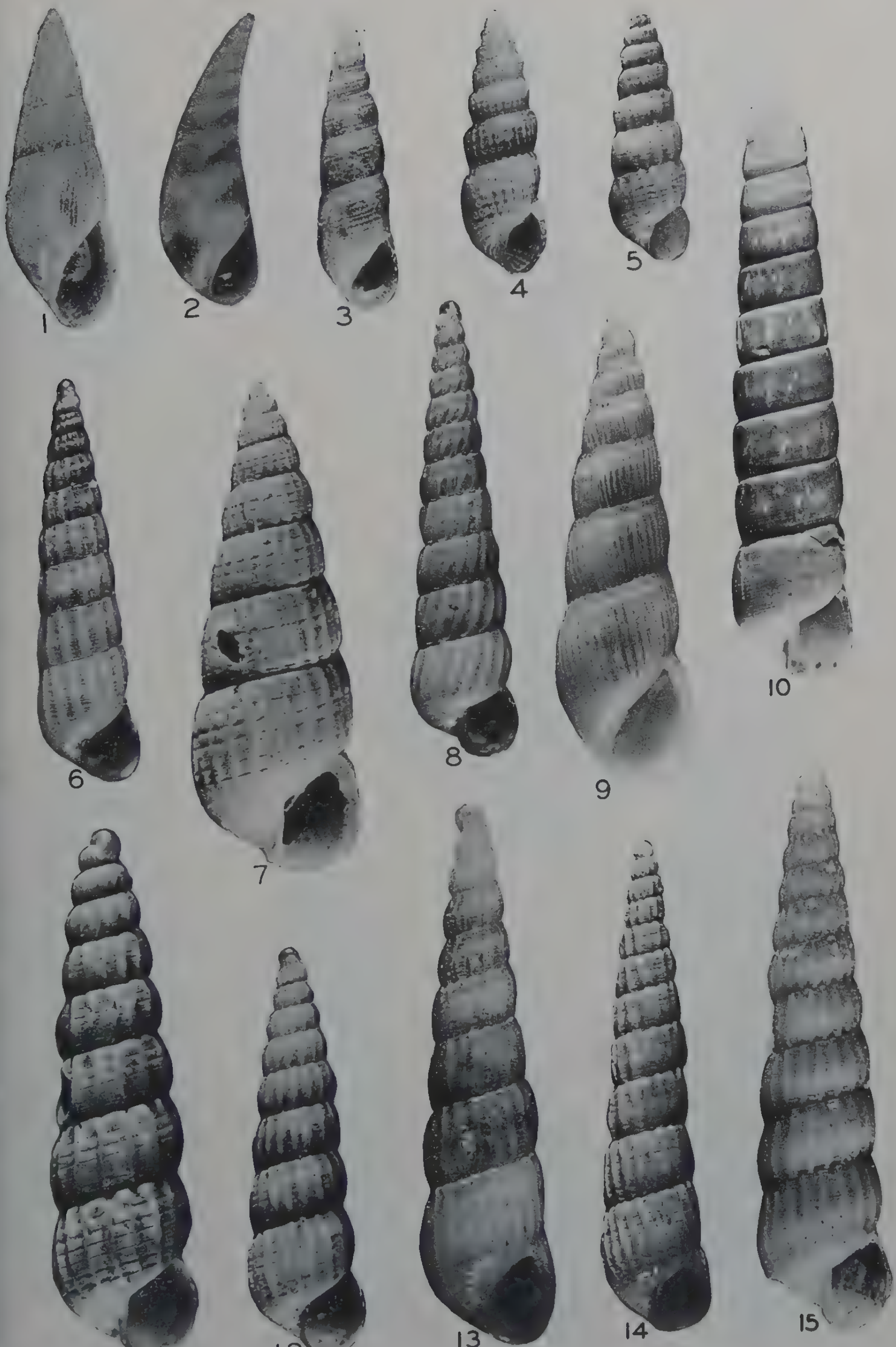

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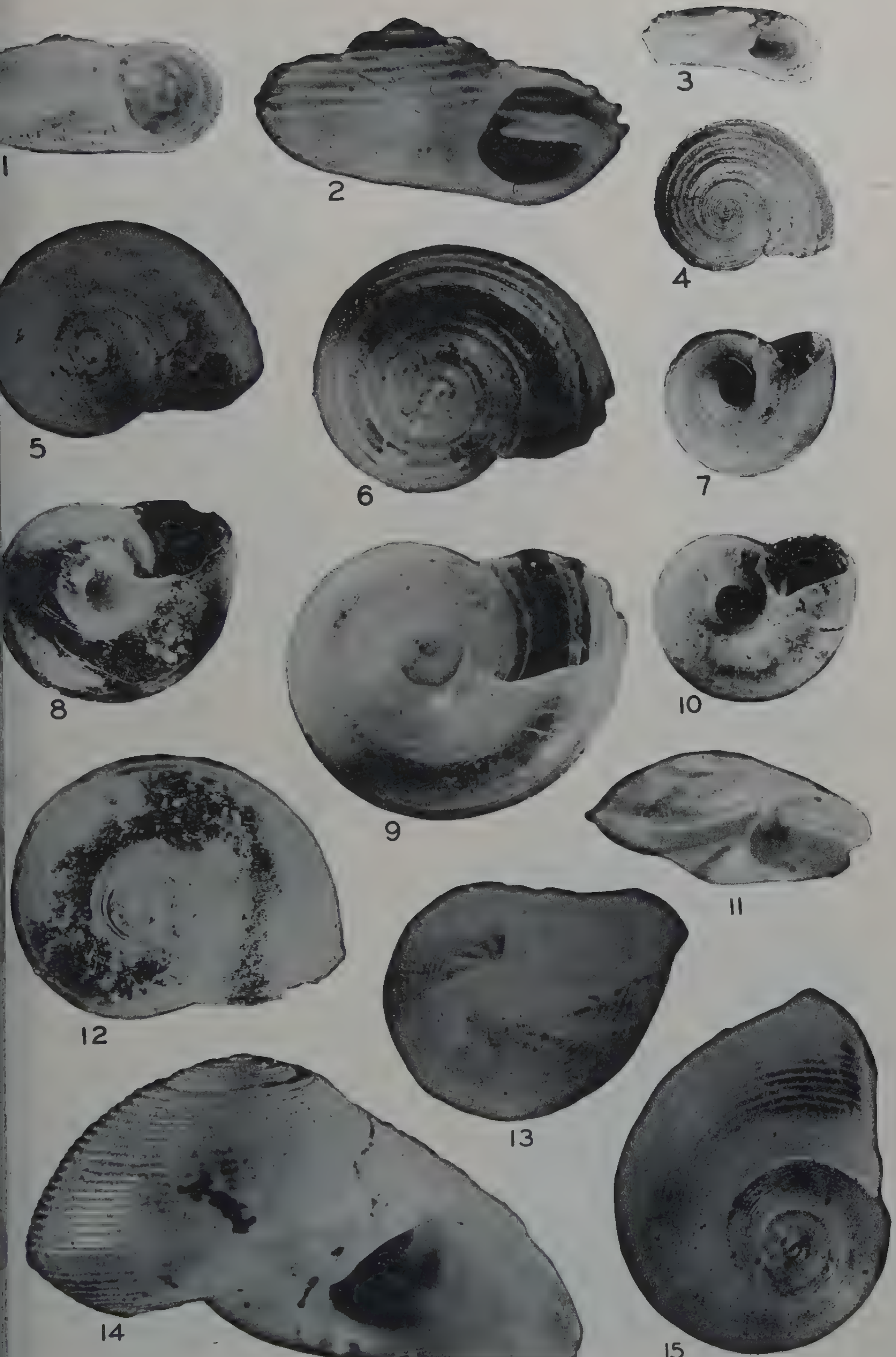

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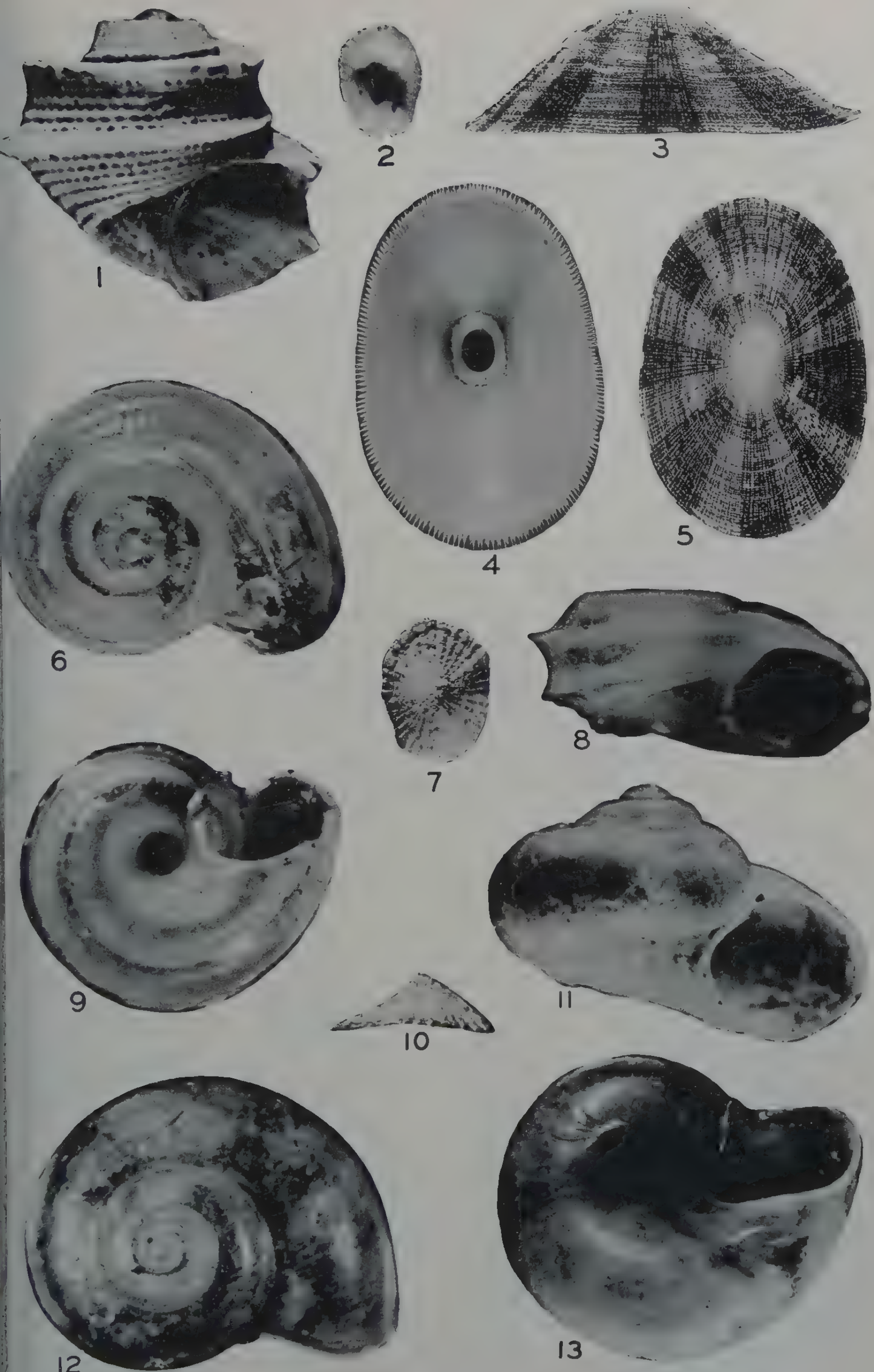

MOLLUSKS FROM THE WEST COAST OF MEXICO AND CENTRAL AMERICA. X.

MOLLUSKS FROM THE WEST COAST OF MEXICO AND CENTRAL AMERICA. X.

6.

Spontaneous Neoplasms in Fishes. V. Acinar Adenocarcinoma of the Pancreas in a Hybrid Platyfish.

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(Plates I-VIII; Text-figure 1).

INTRODUCTION.

Pancreatic tumors in fishes have never een reported. Among thousands of vivip-rous killifishes bred and reared in the enetics Laboratory of the New York Aqua-ium, and among thousands of others outinely autopsied, only a single adenocar-inoma of the pancreas was found. The istological details of this tumor are remark-bly similar to those of comparable pancre-tic neoplasms in man.

MATERIALS AND METHODS.

The tumor of the pancreas was found in a 6-months-old male hybrid platyfish, *Platy-oecilus variatus* × *Platypoecilus xiphidium*. he genetic history of this fish is as follows. ts female parent was a Spike-tail Platyfish, *Platypoecilus xiphidium*, of a stock originally btained from the Rio Purificacion, Tamau-ipas, Mexico. Its male parent was a Variatus Platyfish, *Platypoecilus variatus*, of a stock riginally obtained from a pool at El Nilo, robably associated with the Rio Tampaon, San Luis Potosi, Mexico. The female ex-hibited, at the anterior margin of the caudal fin, two heritable color patterns, called *cres-cent* and *cut-crescent* which may be referred to the dominant autosomal genes *C* and *Ct*, respectively (Text-fig. 1). With the recessive gene, here referred to by plus signs (+), these form a series of three multiple alleles. The male was heavily spotted with large melanophores, and this heritable trait may be referred to the independent, dominant, spotted gene *Sp*. As will be seen by the results obtained from the mating of these individ-uals, the male was apparently heterozygous for the spotted gene (*Sp*+):

P₁

Platypoecilus xiphidium Female	*Platypoecilus variatus* Male
Crescent and Cut-Crescent	Black spotted
++ *CCt*	*Sp*+ ++

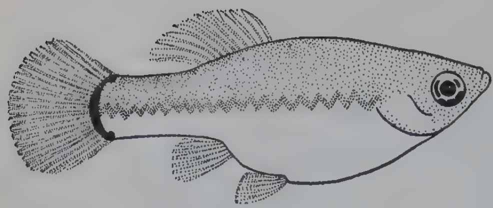
F₁
(Pedigree h3)

	Daughters	Sons
Sp+ *C*+ (spotted, crescent)	5	3
Sp+ *Ct*+ (spotted, cut-crescent)	1	4
++ *C*+ (no spots, crescent)	8	6
++ *Ct*+ (no spots, cut-crescent)	4	1
Totals	18	14

The results indicate that the *C* and *Ct* genes are probably allelic, since they segre-gate approximately equally among the first generation hybrids (Plate I, Fig. 1). The spotted gene segregates independently and is found only in about half of the hybrids. The hybrid with the pancreatic tumor was one of the three males that were spotted and had a crescent pattern (Text-fig. 1).

The external manifestation of the tumor in this fish was a swollen belly, which had developed gradually. The behavior of the fish, however, did not indicate any functional disturbance up to and including the time at which it was sacrificed. Autopsy revealed a large tumorous growth between the folds of the intestine, the main mass being posterior and ventral in position. The intestine, liver and spleen were displaced and the gall blad-der was greatly distended with a yellowish, watery bile. The kidneys were intact and typical in external appearance. Although the fish had a well developed gonopodium and was presumably a male, no testis or gonadal tissue were found. With the exception of the kidneys, all the viscera, including the tumor-ous growth, were removed and fixed in Bouin's solution, embedded in paraffin and sectioned at 6 microns. The mounted sections were stained with Delafield's haematoxylin-eosin, Heidenhain's iron-haematoxylin with and without eosin, and by the methods of

1 Supported in part by a grant from the National Cancer Institute, National Institutes of Health, United States Public Health Service.



Platypoecilus xiphidium Female

Platypoecilus variatus Male

Platypoecilus xiphidium × *Platypoecilus variatus* Hybrid

TEXT-FIG. 1. The hybrid platyfish with an acinar adenocarcinoma of the pancreas was found among 32 fish from the mating of a female Spike-tail Platyfish, *Platypoecilus xiphidium,* and a male Variatus Platyfish, *Platypoecilus variatus.*

Giemsa, Mallory and Gomori. The pancreas and other organs of normal specimens of the closely related Common Platyfish, *Platypoecilus maculatus,* were similarly treated for purposes of comparison.

HISTOLOGY OF THE PANCREAS IN *Platypoecilus.*

The exocrine and endocrine parts of the pancreas in the normal platyfish are separate structures (Reiter & Nigrelli, 1949). The exocrine gland is a diffuse organ suspended in the mesentery between the folds of the intestine, extending from the stomach to the posterior end of the intestine. The main portion of the gland, however, is found in the duodenal region (Plate I, Fig. 2).

The lobules of the gland are held together by a loose connective tissue which also contains fat cells and blood vessels (Plate I, Fig. 2). Each acinus consists of a single row of epithelial cells, resting on a delicate reticular membrane and converging towards a central lumen (Plate I, Fig. 3; Plate II, Fig. 4). Centro-acinar cells are sometimes evident. In secreting groups, the inner zone of each cell is filled with acidophilic zymogen granules of varying size, while the outer basophilic portion contains the nucleus (Plate I, Fig. 3). Although the ducts were not traced completely, intercalary and secondary ducts are seen in certain regions (Plate II, Fig. 5). The main pancreatic duct, together with the bile duct, opens on a common papilla in the duodenum (Plate II, Fig. 6). Microscopically, some acinar tissue occurs in the folds of the liver, along the hepatic artery, portal vine, hepatic ducts and surrounding the endocrine lobe (Plate II, Figs. 5 and 6; Plate III, Fig. 7). In some regions, acinar tissue adheres to the serosa of the intestine.

The endocrine part of the pancreas is a single encapsulated organ situated in the region between the liver and the duodenum at the level of the bile duct, Plate III, Fig. 7). The gland is highly vascular and the cells, when treated by Gomori's method, vary from a basophilic to an eosinophilic condition, the former reaction predominating (Plate III, Fig. 8).

STRUCTURE AND GROWTH OF THE ADENOCARCINOMA OF THE PANCREAS.

The neoplastic growth of the pancreas in the hybrid platyfish was identified as an adenocarcinoma of the acinar type. The major part of the growth formed a solid mass between the folds of the intestine (Plates IV and V); groups of acini were scattered in surrounding regions. The main mass and region of most proliferation was found towards the posterior end of the gut, ventral in position (Plate V, Figs. 13 and 14). Only a mild inflammatory reaction was present but necroses and haemorrhages were extensive in many areas (Plate V, Figs. 13 and 14) Plate VI, Fig. 16).

The tumor was massive and destructive to surrounding tissues (Plate V, Figs. 13 and 14) but no metastases were found. The primary and secondary ducts were obliterated by the neoplasm, but in regions where normal acini were present, intercalated elements were evident. The growth also penetrated the serosa and invaded the *muscularis* of the intestine in certain regions (Plate V, Fig. 12). Both the endocrine part of the pancreas and the testis were wanting. It is assumed that these structures were completely destroyed by the tumor, since the greatest proliferation of neoplastic cells was found in the regions where these organs are normally situated. The kidneys in the diseased

sh showed hydropic degeneration. This organ, the liver and the spleen, contained large mounts of haemosiderin.

Histologically, the growth consisted of cinar elements supported by a delicate vascular reticulum. An increase in connective issue was found in certain areas (Plate VII, Fig. 18; Plate VIII, Fig. 20). In the anterior egion of the body, at the level of the tomach, a few normal-appearing acini were resent. At the level of the duodenum, the land had a compact appearance (Plate IV, Fig. 9), which under high magnification revealed numerous degenerated acinar cells, closely packed but not arranged in acini (Plate VIII, Fig. 22). In more distal parts of the growth (Plate VI, Fig. 17), the cells showed evidence of considerable proliferative activity, with varying degrees of anaplasia. Some areas showed distinct lobule formation in which there seemed to be some attempt to form acini (Plate VII, Fig. 18). In most regions, however, the growth had a disorganized appearance with many isolated cells (Plate VII, Fig. 19). These were comparatively small, spherical or oval, but contained typical nuclei. Only a few mitotic figures were found. The distinct polarization of the cytoplasm, showing the basophilic basal zone and acidophilic inner zone, was lacking (Plate VII, Fig. 18; Plate VIII, Fig. 20); instead, the entire cell was filled with zymogen granules of various sizes, resulting in an overall acidophilic appearance.

The surrounding regions showed extensive areas filled with secretion-like coagulum (Plate V, Figs .13 and 14; Plate VI, Fig. 15), probably resulting from the liquefaction of the released zymogen granules (Plate VIII, Fig. 21) or from gelatinous changes of the tissues.

Discussion.

Schlumberger & Lucké (1948) pointed out that "Malignant tumors of gland-cell origin are the predominant cancers in man. By contrast, but few examples, 7 in all, have hitherto been reported in fishes." They noted, however, that "This fact does not permit us to conclude that this kind of cancer is uncommon in fishes; it may mean that an adequate search has not yet been made. This supposition is the more plausible because most adenocarcinomas originate in the viscera, and not on the body surface as do the epitheliomas." According to these authors, adenocarcinomas of the kidney, ovary, rectal gland, thyroid and the glandular elements of the skin, mouth and operculum have been described in fishes. Tumors of the pancreas have not been previously reported for either fishes or amphibians. Ratcliffe (1935, 1943) described several cases of a neoplastic-like disease of the pancreas in more than a dozen species of snakes, but he has recently (in Lucké & Schlumberger, 1949) questioned his previous interpretation.

The majority of pancreatic tumors of man (Ewing, 1940; Willis, 1948) and other mammals (Fox, 1923; Kresky & Barnett, 1939) usually arise from the epithelial elements of the pancreatic ducts or from the islands of Langerhans. Tumors in which acinar elements are involved are often difficult to recognize because of metaplastic changes. The cell morphology may be so completely altered that the presence of zymogen granules or enzymes is the only evidence on which to base the origin of the growth.

In the pancreatic tumor found in the hybrid platyfish, the growth occurred in a region which may correspond to the tail of the pancreas in mammals. The acinar elements are more or less typical but are irregularly arranged and the cells, often isolated, lack the characteristic polarization of the zymogen granules seen in normal pancreatic tissue.

No evidence was obtained which would indicate the cause of this pancreatic tumor. Although the genetic history of the fish involved is given above, hereditary factors as the cause of the tumor are not implied.

It has been suggested that inflammatory changes may often be the cause of human pancreatic carcinomas. Willis (1948), however, stated that "Inflammatory changes in the pancreas accompanying cancer are in most cases clearly secondary to duct obstruction caused by the growth." In this connection, the fat necrosis of the pancreas described by Plehn (1939) in certain Chinese carp kept in captivity is of interest. The gland in these fish was not only present as a typical structure, but in addition pancreatic elements were widely scattered in the mesentery as small aggregations and as isolated cells. Inflammatory reactions were accompanied by granulation tumors and infiltrative cancer-like growths. The secretion from the gland-like aggregations destroyed the fat tissue and blood vessels of the surrounding regions. Plehn concluded that conditions of captivity and over-feeding were probably responsible for this disease. It is probable, however, that the inflammatory changes were secondary to the cancer-like growths, as suggested by Willis for mammalian carcinomas.

The isolated aggregations of pancreatic cells seen by Plehn in diseased carp occur more or less frequently in normal fishes. Boldyreff (1935) and others have shown that the amount and distribution of normal acini in fishes vary considerably with the species and, from our own observations, even with individuals of the same species. In fishes the pancreas appears to be a highly plastic organ, and it is our belief that a more intensive study of the gland in these animals might reveal a higher incidence of hyperplasia and neoplasia. In addition, such a study would have phylogenetic importance since it would perhaps provide evidence as to the origin of the aberrant or heterotopic pancreatic tissue often encountered in humans which, according to Ewing (1940), probably gives rise to certain localized carcinomas of this gland.

Summary.

An acinar type of adenocarcinoma of the pancreas in a 16-months-old, male hybrid platyfish, *Platypoecilus variatus* × *Platypoecilus xiphidium*, is described. No metastases were found, but there was evidence of invasion and destruction of the surrounding tissues. The comparative pathology of pancreatic tumors in vertebrates, including man, is discussed.

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EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. A normal brother and sister of the male *Platypoecilus xiphidium* × *Platypoecilus variatus* hybrid which developed a pancreatic tumor. The female, to the left, has the spotted pattern (*Sp* gene) and the cut-crescent pattern (*Ct* gene). The male, to the right, is unspotted (*sp* or + gene) and has the crescent pattern (*C* gene). Life size. Photographed by S. C. Dunton.

Figures 2-8 are photomicrographs of sections of normal *Platypoecilus maculatus*, showing the distribution and relations of the pancreas to surrounding organs.

Fig. 2. Pancreas at the level of the spleen and duodenum. The light areas in the gland are fat cells and blood vessels. Delafield's haematoxylin-eosin. 50 ×.

Fig. 3. Groups of acini showing structure and arrangement typical of vertebrate pancreas. Note nucleus in darker basophilic zone and zymogen granules in lighter inner zone. Delafield's haematoxylin-eosin. 2500 ×.

Plate II.

Fig. 4. Acinar groups stained with Gomori's chrome alum haematoxylin-phloxin. Note centro-acinar cell in upper group. 2500 ×.

Fig. 5. Section at the level of the gall bladder and duodenum, showing typical pancreatic tissue around blood vessel. Note secondary ducts in cross section. Masson's. 1500 ×.

Fig. 6. Primary duct, together with the bile duct opening on a papilla in the duodenum. The dark-staining areas are groups of acinar tissue surrounding blood vessels in the region of the liver. Giemsa's. 750 ×.

Plate III.

Fig. 7. Endocrine gland or islet tissue of the pancreas. This encapsulated structure is found at the level of the gall bladder. Masson's. 750 ×.

Fig. 8. Details of the cellular elements of the islet tissue. The cells grade in staining reaction from a basophilic to an eosinophilic condition, with the former predominating. Gomori's chrome alum haematoxylin-phloxin. 2000 ×.

Figures 9-22 are photomicrographs of sections of pancreatic tumor in a male hybrid, *Platypoecilus variatus* × *Platypoecilus xiphidium*.

PLATE IV.

Fig. 9. Section at the level of the posterior part of the liver, showing a massive, encapsulated-appearing tumor. For details see Plate VIII, Fig. 22. Delafield's haematoxylin-eosin. 25 ×.

Fig. 10. Pancreatic tumor at the level of the mid-intestinal region. Note associated effects (atrophy) on the intestine. Delafield's haematoxylin-eosin. 25 ×.

Fig. 11. Pancreatic tumor at the level of the large intestine. Delafield's haematoxylin-eosin. 25 ×.

PLATE V.

Fig. 12. Details showing infiltration into the *muscularis* of the intestine. In normal fish pancreatic tissue may adhere to the serosa. Masson's. 2000 ×.

Fig. 13. The main mass and region of most proliferation was found in the region ventral to the large intestine. Note extensive areas with secretion-like coagulum. Delafield's haematoxylin-eosin. 25 ×.

Fig. 14. Another section similar to the one illustrated in Fig. 13, showing effects on surrounding connective tissue. Delafield's haematoxylin-eosin. 25 ×.

PLATE VI.

Fig. 15. Higher magnification of region at the periphery of the coagulum-like secretion, showing active secreting acinar elements. Giemsa's. 300 ×.

Fig. 16. Area within the pancreatic tumor, showing an extensive haemorrhage. Delafield's haematoxylin-eosin. 75 ×.

Fig. 17. Low power magnification of a central region of the pancreatic tumor, showing a compact but irregular arrangement. Delafield's haematoxylin-eosin. 500 ×.

PLATE VII.

Fig. 18. Higher magnification of an area shown in Fig. 17, showing the arrangement of the acinar elements. Delafield's haematoxylin-eosin. 2000 ×.

Fig. 19. Another area of the region shown in Fig. 17, showing isolated acinar cells with little or no zymogen granules. Delafield's haematoxylin-eosin. 2000 ×.

PLATE VIII.

Fig. 20. Cytological details of cells of the pancreatic tumor. Note variability in size, loss of typical acinar arrangement, loss of polarization of cytoplasm. The nuclei are typical. Delafield's haematoxylin-eosin. 5000 ×.

Fig. 21. Area showing numerous zymogen granules released into surrounding region. Iron-haematoxylin. 1500 ×.

Fig. 22. Details, showing degenerate cells in the tumor mass shown in Fig. 9. Delafield's haematoxylin. 2500 ×.

FIG. 1.

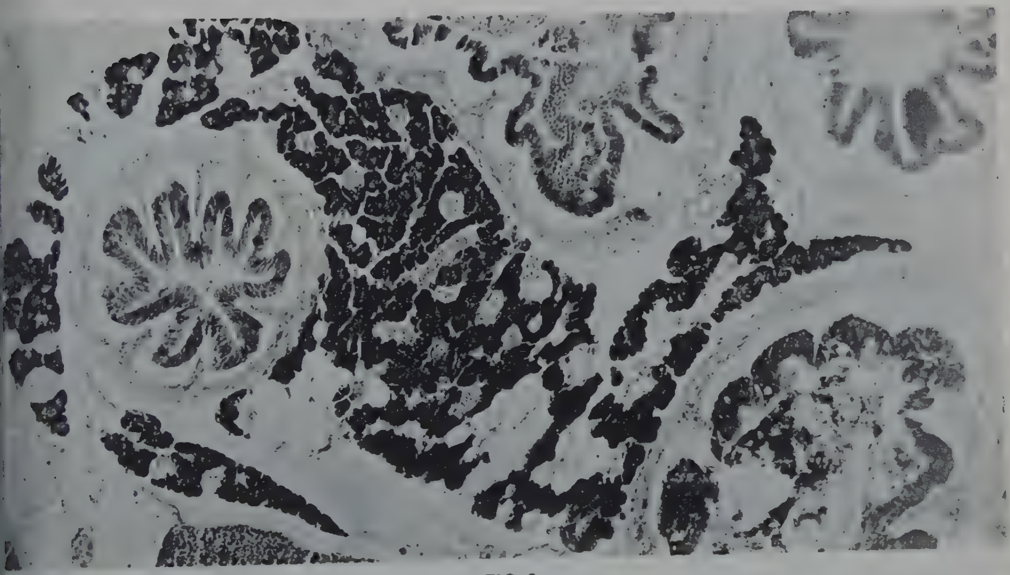


FIG. 2.

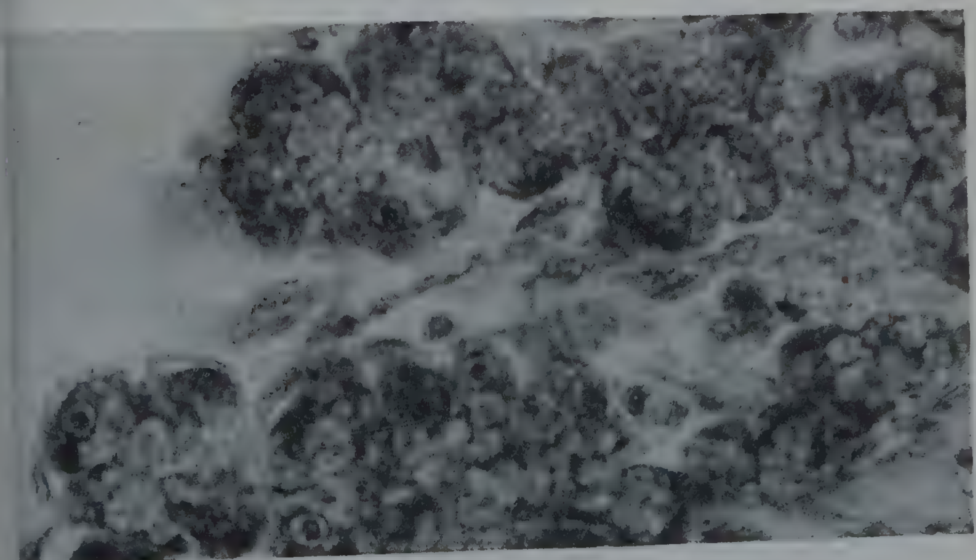


FIG. 3.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

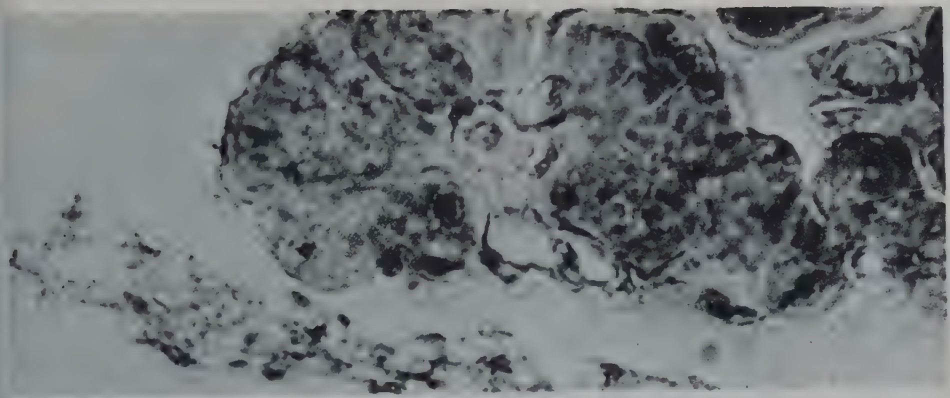


FIG. 4.

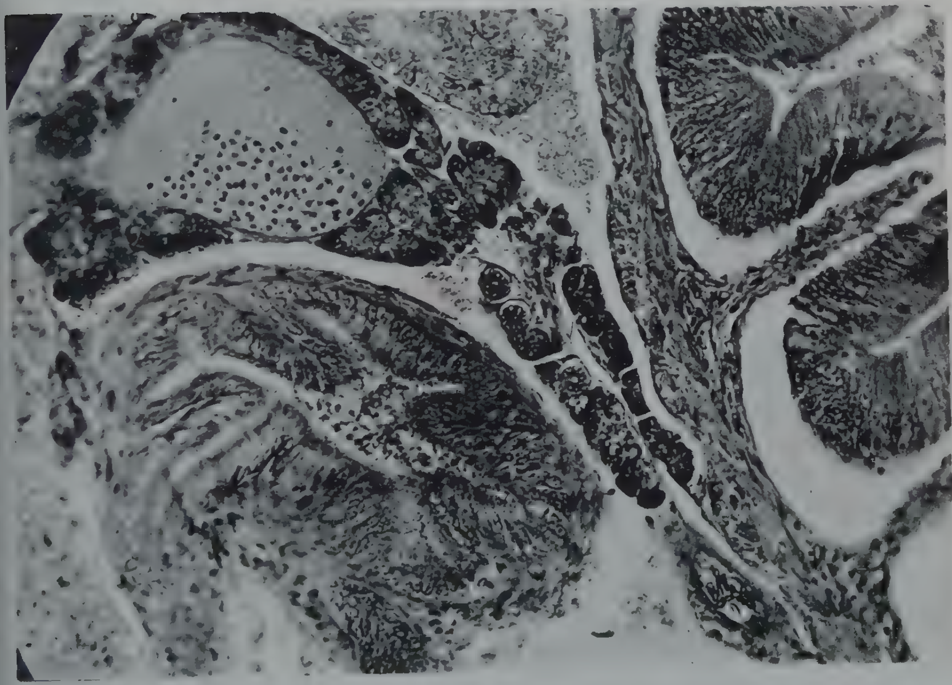


FIG. 5.

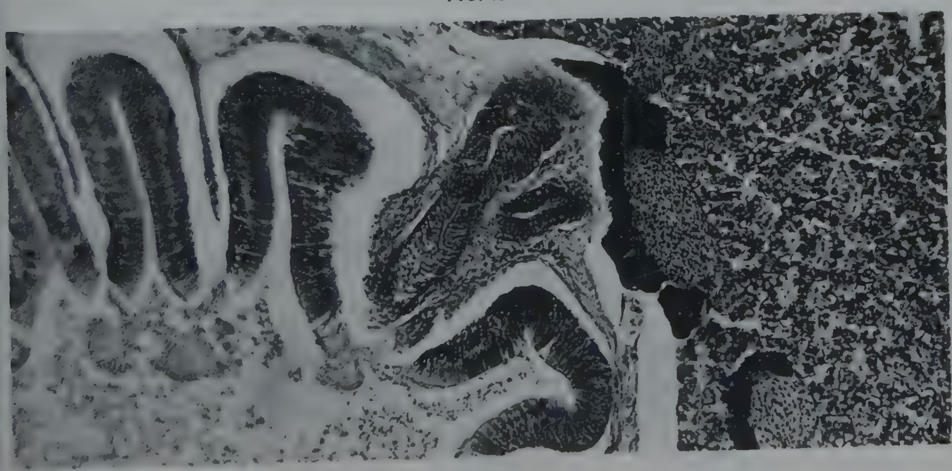


FIG. 6.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

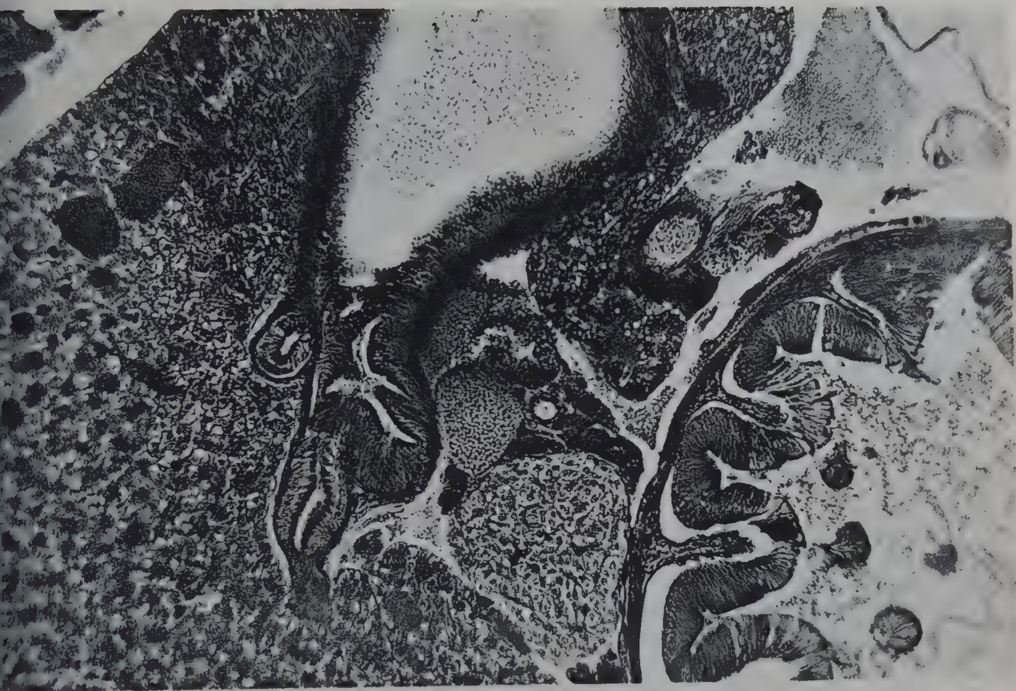


FIG. 7.

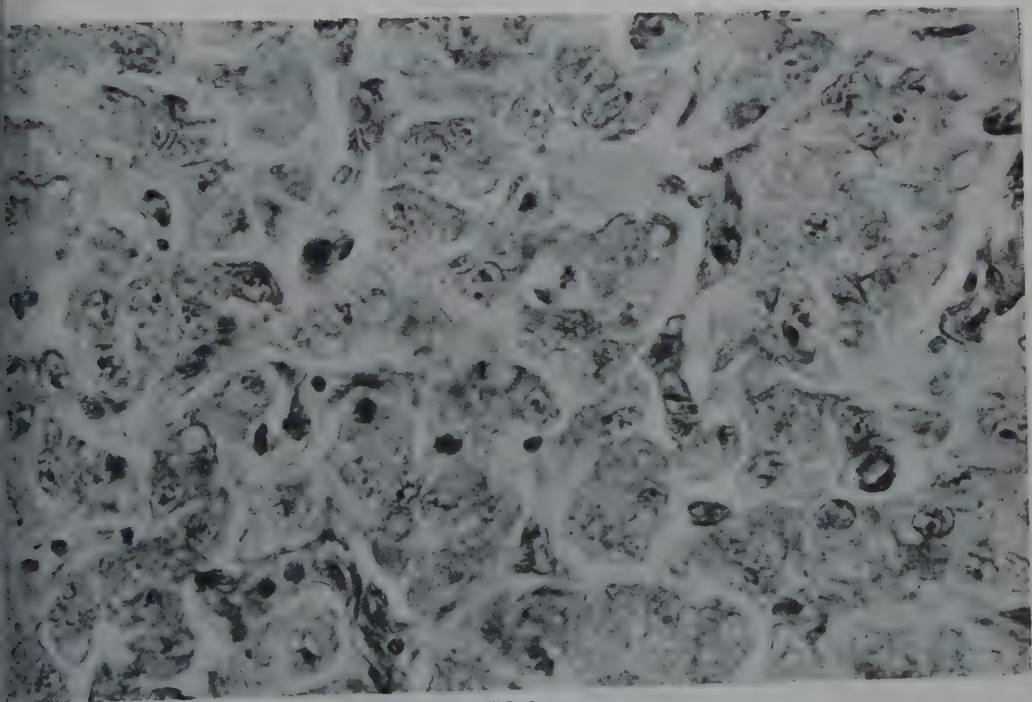


FIG. 8.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

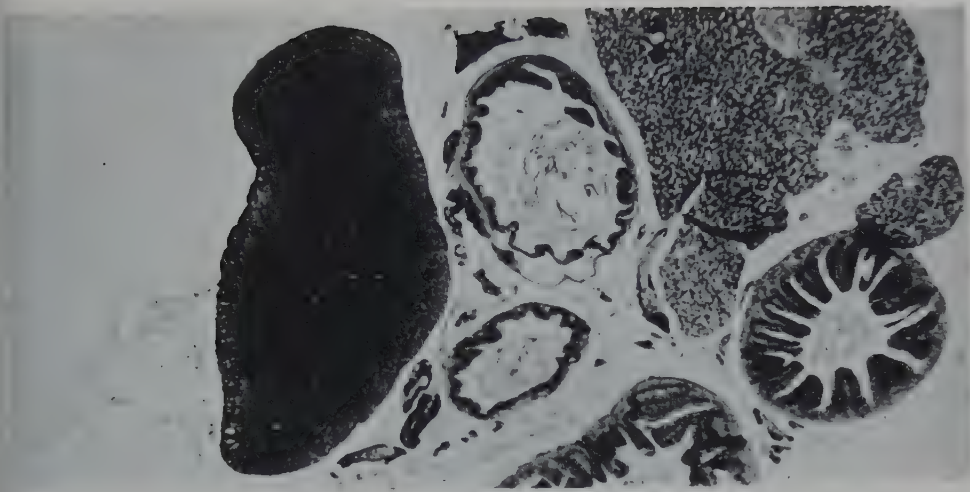


FIG. 9.

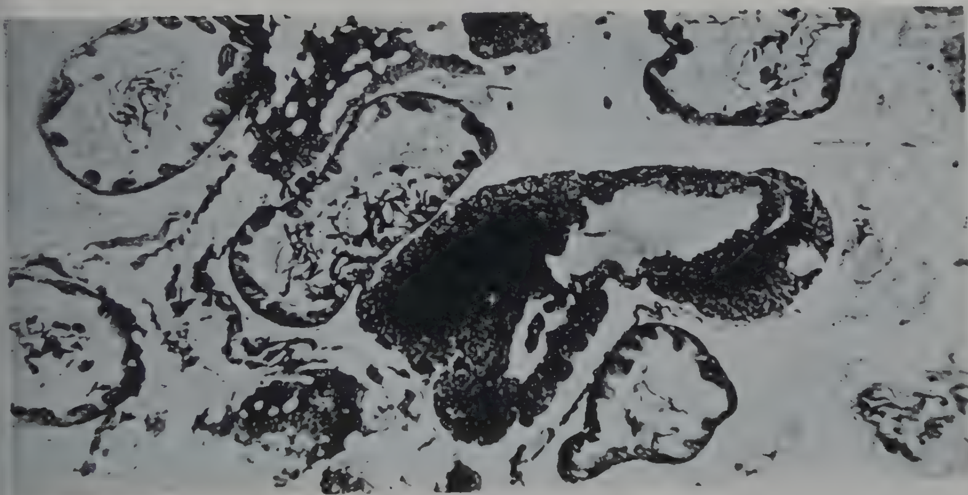


FIG. 10.

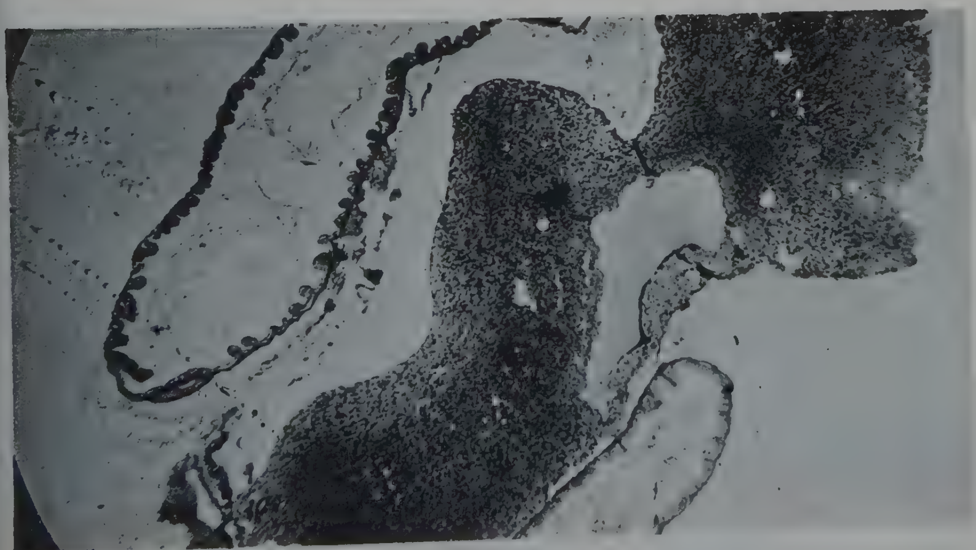


FIG. 11.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

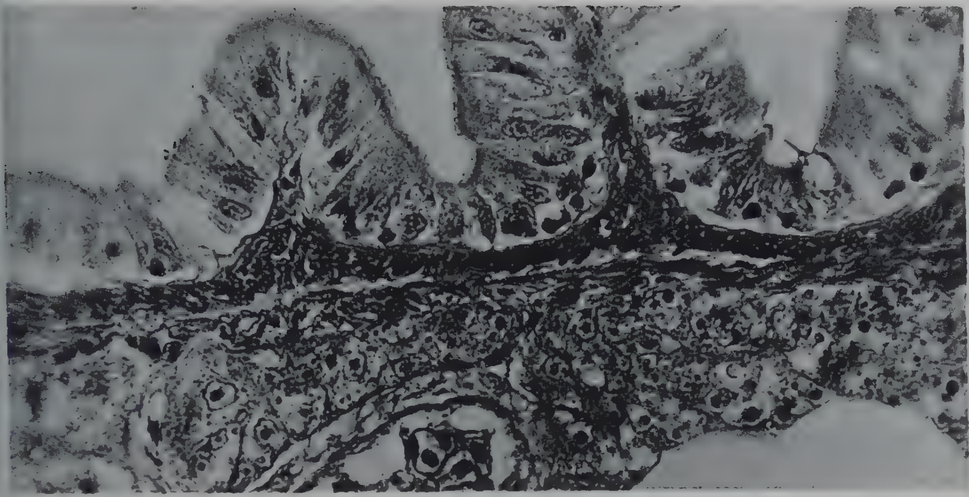


FIG. 12.

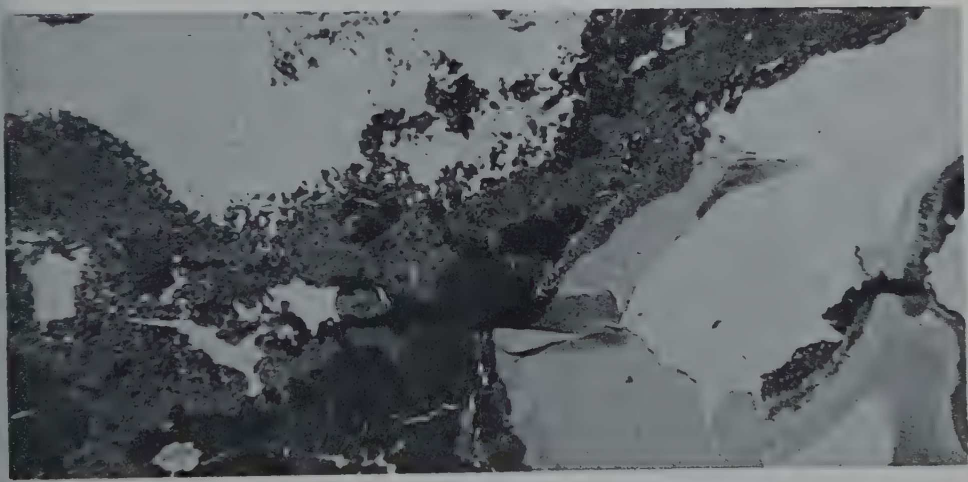


FIG. 13.

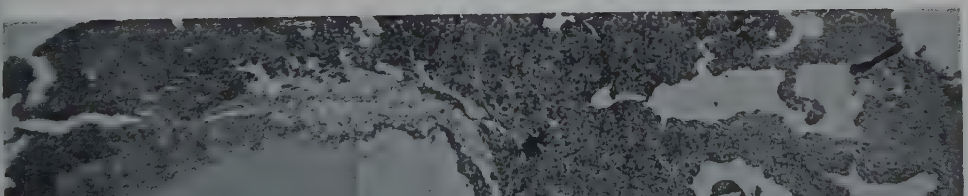


FIG. 14.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

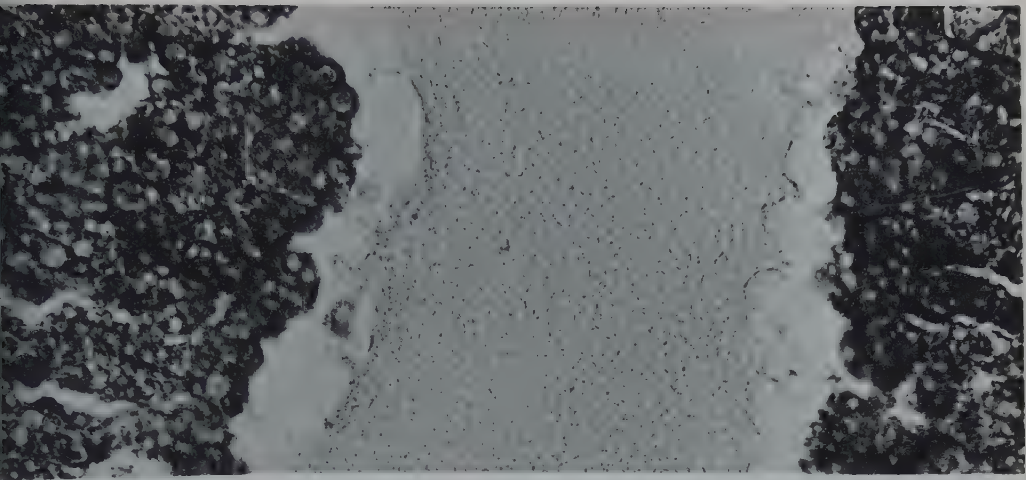


FIG. 15.

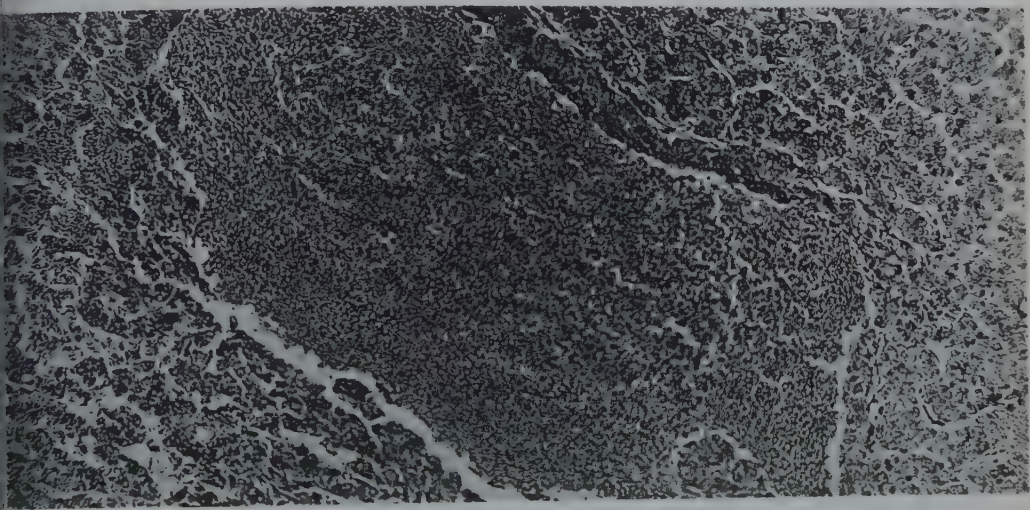


FIG. 16.

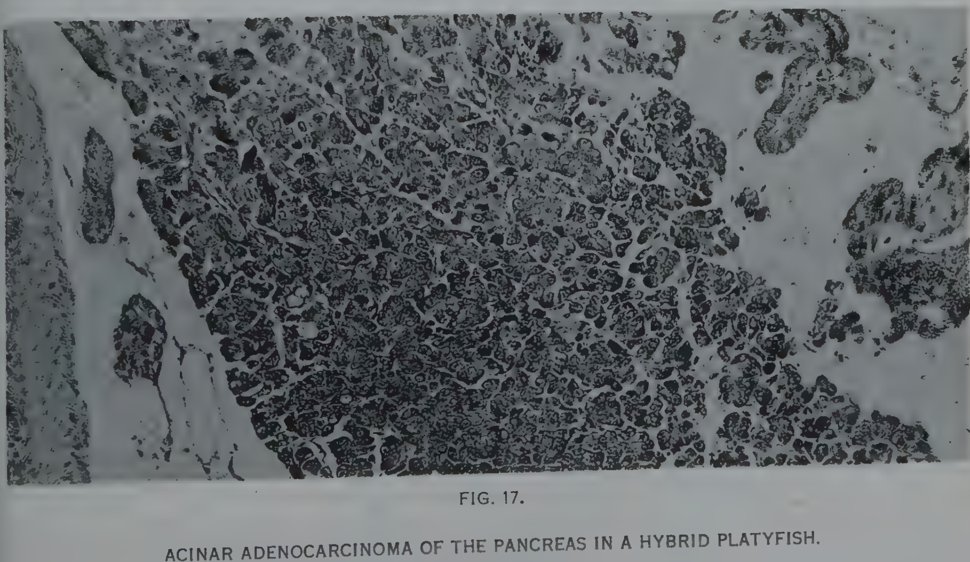


FIG. 17.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

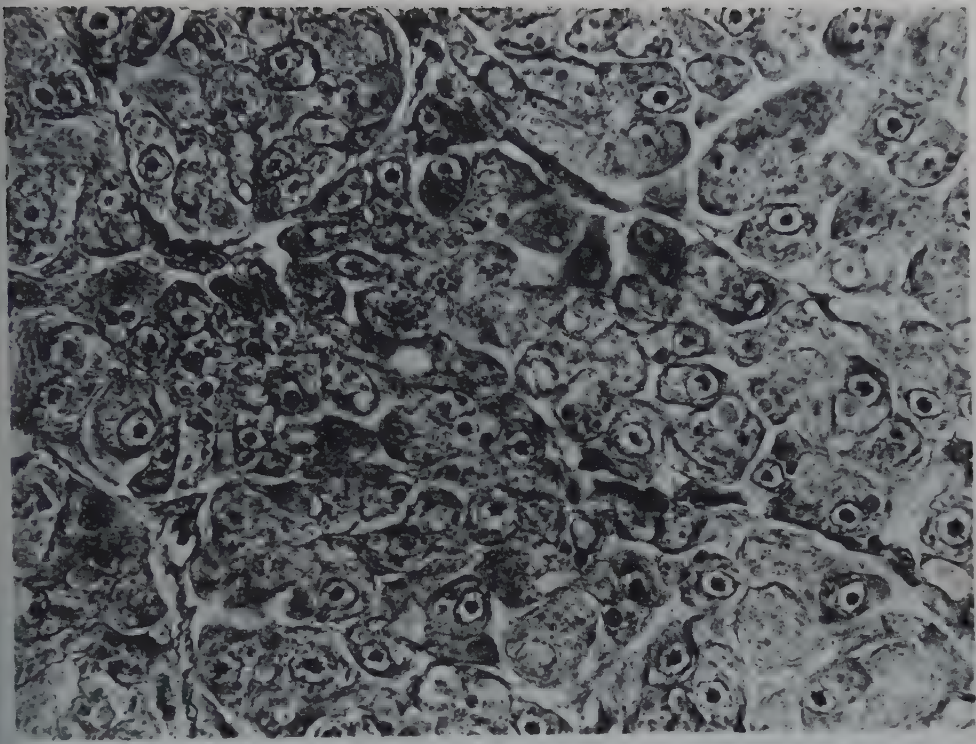


FIG. 18.

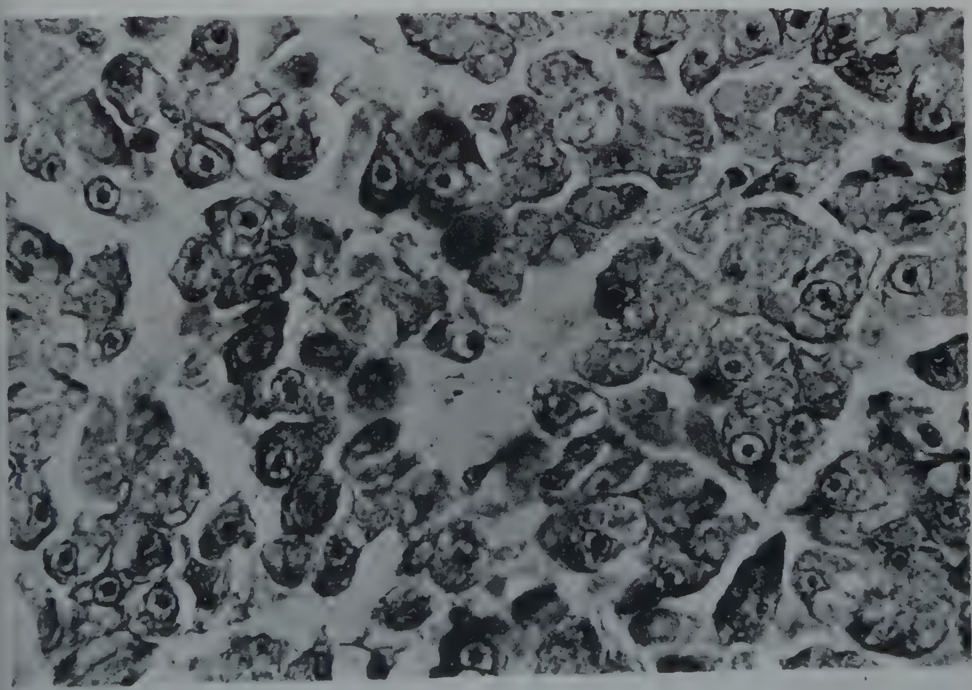


FIG. 19.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

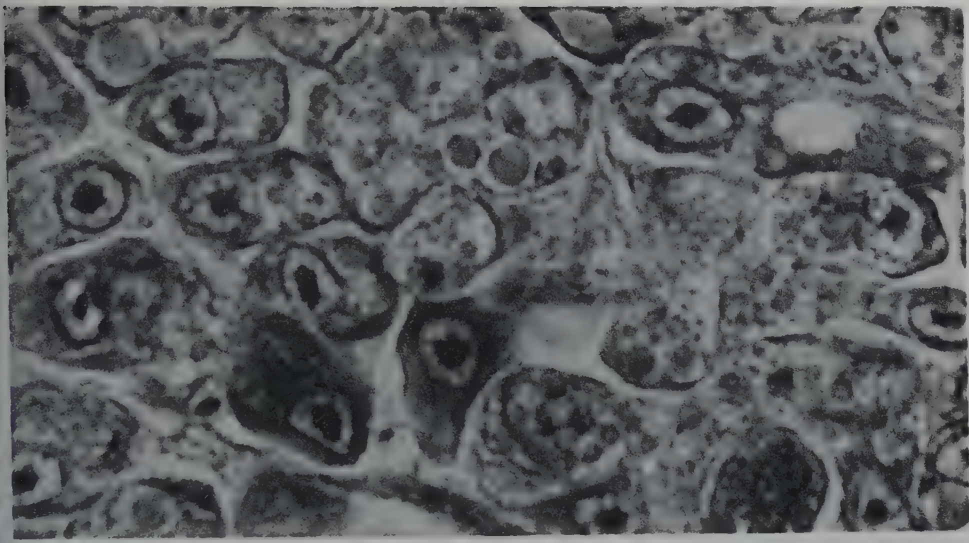


FIG. 20.

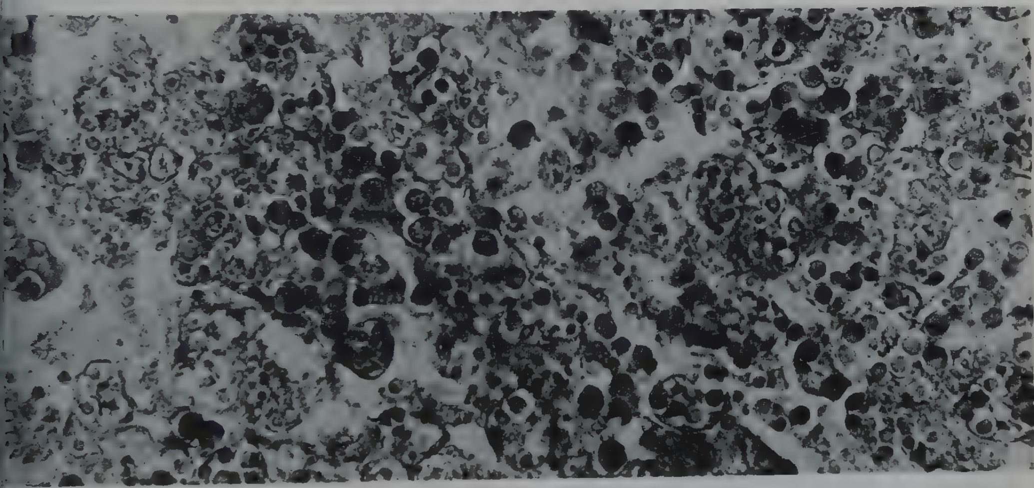


FIG. 21.

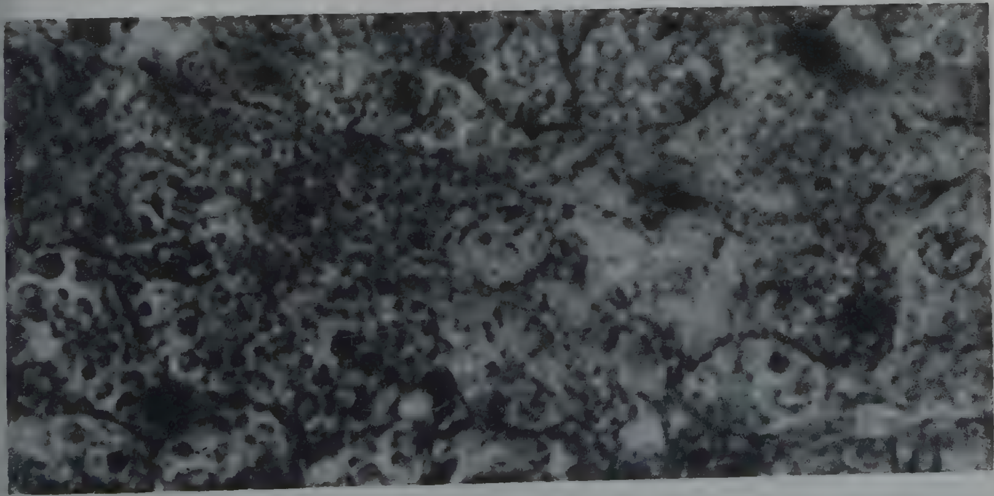


FIG. 22.

ACINAR ADENOCARCINOMA OF THE PANCREAS IN A HYBRID PLATYFISH.

7.

Genetics of *Platypoecilus maculatus*. V. Heterogametic Sex-determining Mechanism in Females of a Domesticated Stock Originally from British Honduras.

MYRON GORDON.

Aquarium, New York Zoological Society.[1]

(Plates I & II; Text-figure 1).

The platyfish, *Platypoecilus maculatus*, has two types of genetic mechanisms for sex determination. In members of three natural river populations from Mexico, the males are heterogametic, XY, the females are homogametic, XX; on the other hand, in members of domesticated stocks under observation for 25 years in laboratories in this country and in Europe, the female platyfish are heterogametic, WY (or WZ) and the males are homogametic, YY (or ZZ) according to recent surveys of Gordon (1946b, 1947a, 1950).

In this study the theoretical chromosomal formula of the heterogametic female is being expressed as WY rather than WZ, the homogametic male as YY rather than ZZ, because the author (1946b) demonstrated that the Z chromosome is synonymous with the Y in this species of platyfish. The reason for using WY—YY rather than XY—YY, as suggested sometime ago by Castle (1936), will be discussed later.

MATERIAL.

In the summer of 1947 the Genetics Laboratory received, through the courtesy of Mr. Albert Greenberg, three pairs of the "salt-and-pepper" strain of *P. maculatus* from the Everglades Aquatic Nurseries of Tampa, Florida. Mr. Greenberg said that in 1939 he had collected the original stock of this color variety in streams near the city of Belize in British Honduras. Since that time they have been bred in large, concrete containers for commercial purposes. The platyfish were uniformly marked with prominent black pigment spots on a white background, the males being slightly more heavily spotted than the females. The macromelanophores formed small, discrete pigmented units. Under the lens a few micromelanophores were found between the tight clusters of macromelanophores, but xanthophores or erythrophores, if present, could not be seen.

The posterior area of the caudal peduncle of both males and females had small areas of deeper pigmentation. In some fish of this British Honduras commercial stock the upper and lower parts of the caudal peduncle were darker while in others the central portion was the darker, which made it likely that this strain had some tail patterns. Probably the twin-spot, P^T, was present in some, while others had the one-spot P^O, patterns. The genes for these additional patterns were shown to be autosomal in other strains of platyfish, according to Gordon (1947b).

The salt-and-pepper platyfish will be referred to as the British Honduras commercial or domesticated stock and designated as BH.

GENETIC ANALYSIS.

Each of the three original gravid salt-and-pepper platyfish females was isolated in a four-gallon laboratory aquarium. Their breeding behavior is indicated in Table 1. Females BH-1 and BH-2 produced offspring of essentially similar phenotypes and in the following ratios:

1. Macromelanophore spotting heavy, on white background, like their parents: females, 25%; males, 50%.
2. Macromelanophore spotting faint, on red background, unlike their parents: females, 25%.

Obviously the strain was not true-breeding, for 25% of the brood (all of which were female) were unlike their parents in color. The unlike forms were faintly black-spotted and red, and they resembled the stock mentioned by Kosswig and referred by him and by Breider (1937) to the gene *Sp'R*. This single term *Sp'R* may actually represent two distinct, but closely linked, genes, *Sp'* for macromelanophores and *R* for xanthoerythrophores. For a general discussion of this point see Fraser & Gordon (1929).

The results observed from females BH-1 and BH-2 were obtained again in matings of

[1] From the Genetics Laboratory of the New York Zoological Society at the American Museum of Natural History, New York 24, N. Y. This work on the inheritance of the macromelanophores is supported by a grant from the National Cancer Institute, National Institutes of Health of the U. S. Public Health Service for the project: "Genetic and Correlated Studies of Normal and Atypical Pigment Cell Growth." The author wishes to thank James W. Atz, Olga Aronowitz and Donn Eric Rosen for reading the manuscript.

some of their salt-and-pepper offspring; see experiments 4 and 5 of Table 1. When two salt-and-pepper daughters, BH^{2}A1 and BH^{2}B1, were mated with their similarly colored brothers, they produced only salt-and-pepper sons; one-half of all the daughters produced were black and white like their brothers, but half of the daughters were faintly black-spotted and red in color.

The results obtained in matings 1, 2, may be explained either by assuming:

1. The female was heterogametic, WY, the male homogametic, YY, as follows:

P_1

Female:		Male:
(W)*Sp′R*/(Y)*Sp*+	×	(Y)*Sp*+/(Y)++

F_1

Daughters:	Sons:
A.	C.
(W)*Sp′R*/(Y)++	(Y)*Sp*+/(Y)*Sp*+
B.	D.
(W)*Sp′R*/(Y)*Sp*+	(Y)*Sp*+/(Y)++

2. The male was heterogametic, XY, the female homogametic, XX, as follows:

P_1

Female:	Male:
(X)*Sp′R*/(X)*Sp*+	(X)++/(Y)*Sp*+

F_1

Daughters:	Sons:
E.	G.
(X)*Sp′R*/(X)++	(X)*Sp′R*/(Y)*Sp*+
F.	H.
(X)*Sp*+/(X)++	(X)*Sp*+/(Y)*Sp*+

When the two pairs of salt-and-pepper F_1 were inbred, the results in the F_2 were identical with those obtained in F_1 (compare experiments 4 and 5 with 1 and 2). These results failed to indicate conclusively which of the two types of genetic mechanisms for sex determination is in effect in this strain.

Under formula 1: the spotted daughter and its spotted brother chosen for mating may have been individuals marked B and D. These, it will be noted, have the identical genotypes of their parents.

Under formula 2: the spotted daughter and its spotted brother chosen for mating may have been individuals marked F and G. These, it will be noted, are unlike their parents genotypically yet they would produce phenotypically identical offspring in the F_2 as follows:

F_2

Females:	Males:
J.	L.
(X)*Sp*+/(X)*Sp′R*	(X)*Sp*+/(X)*Sp*+
K.	M.
(X)++/(X)*Sp′R*	(X)++/(X)*Sp*+

The female individual marked K would appear red with faint black spotting. All the rest of the females would be darkly spotted and so would all the males.

Obviously, if enough F_1 matings were set up individually and tested through F_2, one would probably get results which would ha[ve] eliminated one of the two mechanisms b[y] these methods alone.

The breeding performance of the thi[rd] salt-and-pepper female platyfish, BH-3, th[at] was born, reared and bred at Tampa, Florid[a] was much like those of its sisters. But in a[d]dition to the types and frequencies of tho[se] types which BH-1 and BH-2 produced, BH[-3] produced a single, strongly black-band[ed] form, indicated in Table 1, experiment [ ] under the phenotype *N*. The gene *N* repr[e]sents *nigra* a well-known sex-linked col[or] pattern, described early by Bellamy (192[ ]) and studied by Gordon (1937). Beneath th[e] broad band of black pigment and spreadin[g] out and radiating away from the black ban[d] the exceptional *N* female had a suffusion [of] reddish color. This may have indicated th[at] it was carrying the genes *Sp′R* as well as *N*. Apparently the mother of the *N* fish, fema[le] BH-3, had mated with more than one mal[e] one of which was +/*Sp*; another was pro[b]ably *N*/*Sp*.

The results from experiments 1 through [ ] were inconclusive in indicating clearly whic[h] of the two types of genetic sex-determinin[g] mechanisms (XX—XY or WY—YY) was [in] force in the commercial British Hondura[s] stock (see discussion). It was decided, ther[e]fore, to mate one of the British Hondura[s] males with a Rio Jamapa stripe-sided fema[le] of a previously genetically tested stock wit[h] reference to its sex-determining mechanism. This female was known to have two X chr[o]mosomes (XX); and the males of this stoc[k] are XY, according to Gordon (1947a).

By chance, the heavily spotted mal[e] BH-14 was chosen for mating with a strip[e]sided female (X)*Sr*/(X)*Sr* of the R[io] Jamapa population. Phenotypically, the ma[le] BH-14 seemed no darker than the other tw[o] salt-and-pepper males. The results of exper[i]ment 6 in Table 2 indicate that the pair pr[o]duced 183 adult offspring. Every one of the[se] matured and was a male; approximately ha[lf] of them were heavily black-spotted (*Sp*) an[d] half were black-banded (*N*). The color pa[t]terns of the young were clear cut, as was th[e] ratio in which they appeared. From th[is] mating (Text-fig. 1), it was concluded tha[t] the males of the British Honduras stock wer[e] homogametic for the sex-determining chr[o]mosomes, as indicated below:

Rio Jamapa (Mexico)	×	British Honduras (Commercial)

P_1

Female:	Male:
(X)*Sr*/(X)*Sr*	(Y)*Sp*/(Y)*N*

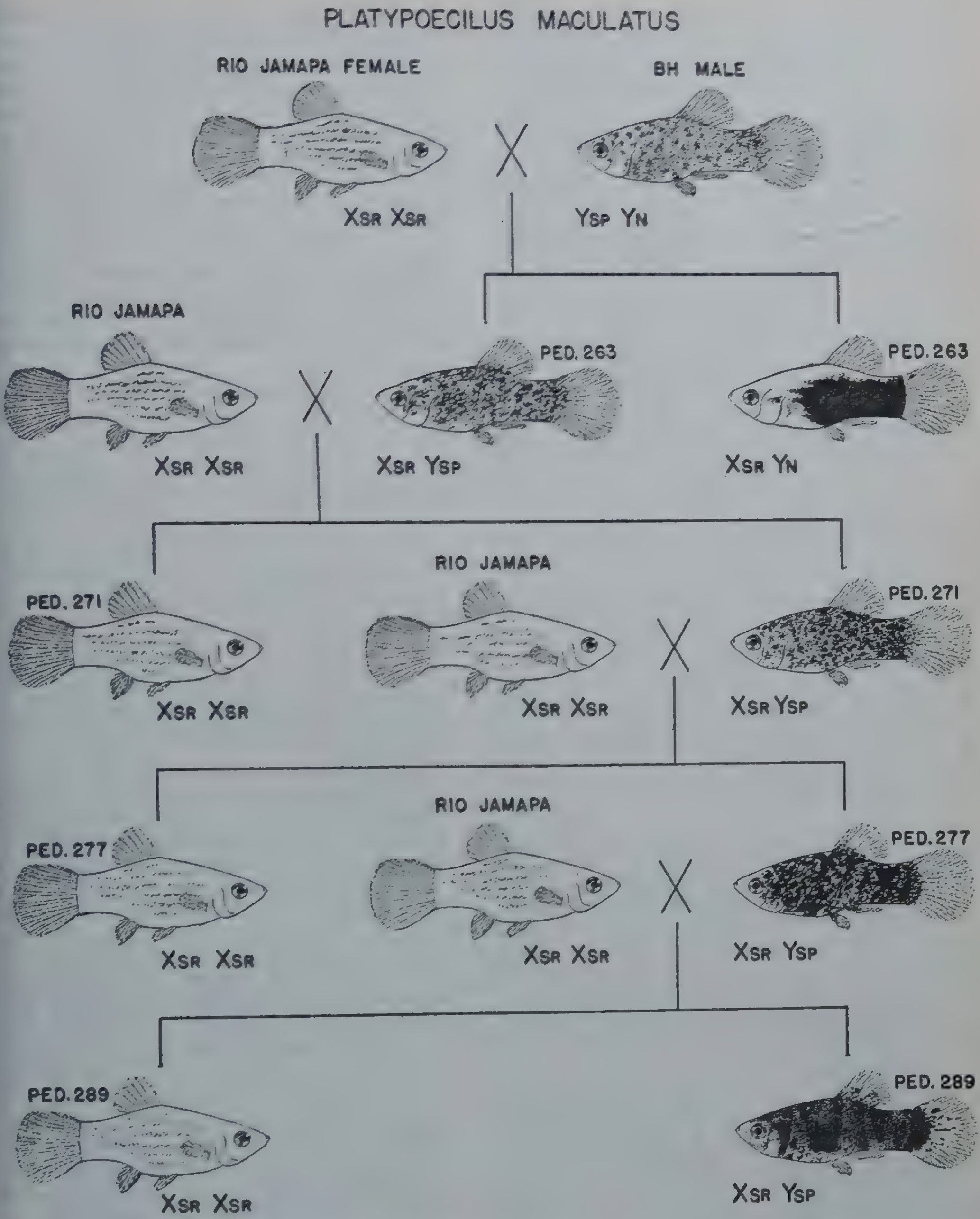
F_1

Pedigree 263

Daughters:	Sons:
None	(X)*Sr*/(Y)*Sp*
	(X)*Sr*/(Y)*N*

This conclusion was substantiated by further mating which follows.

A Rio Jamapa-British Honduras spotte[d]



TEXT-FIG. 1. All-male broods produced by mating a male from the domesticated stock of platyfish originally from British Honduras to a female from an inbred stock of wild platyfish originally from the Rio Jamapa in Mexico. The X and the Y represent the sex chromosomes to which sex-linked genes are attached. The first generation is represented by the pedigree number 263 in which two phenotypes appeared: the spotted, *Sp*, and the black-banded or nigra, *N*. The spotted male was back-crossed to a Rio Jamapa female. They produced only stripe-sided daughters and only spotted sons under the pedigree of 271. This type of back-cross mating was repeated, two more times, but the results were the same; that is, only stripe-sided daughters and only spotted sons were produced. This indicates that the father-to-son inheritance may best be explained by the association of the spotted sex-linked gene *Sp* with the Y chromosome.

Note the increasing density of macromelanophore pigmentation in the successive generations of the *Sp*, spotted males.

TABLE 1.

Genetics of the Domesticated Stock of *Platypoecilus maculatus* Originally from British Honduras.

PARENTS					OFFSPRING											
Exp. No.	Female	Male	Female	Male	Ped. No.	*Sp* ♀	*Sp* ♂	*Sp'R* ♀	*Sp'R* ♂	*N* ♀	*N* ♂	*Sr* ♀	*Sr* ♂	Total	χ^2	p
1	BH-1	BH-11	*Sp'R/Sp+*	*++/Sp+*	BH²A	12	26	10	..	..	..	..	..	48	0.50	.77
2	BH-2	BH-12	*Sp'R/Sp+*	*++/Sp+*	BH²B	16	25	15	..	..	..	..	..	56	0.68	.72
3	BH-3	BH-13 } BH-14 }	*Sp'R/Sp+*	*++/Sp+* } *N+/Sp+* }	BH²C	33	65	30	..	1	..	..	..	129	0.17*	.92
4	BH²A	BH²A	*Sp'R/Sp+*	*++/Sp+*	BH³A	18	33	24	..	..	..	..	..	75	2.62	.27
5	BH²B	BH²B	*Sp'R/Sp+*	*++/Sp+*	BH³B	10	19	8	..	..	..	..	..	37	0.45	.80

TABLE 2.

Exp. No.	Female	Male	Female	Male	Ped. No.	*Sp* ♀	*Sp* ♂	+ ♀	+ ♂	*N* ♀	*N* ♂	*Sr* ♀	*Sr* ♂	Total	χ^2	p
6	$30^{8}5$	BH-14	*Sr/Sr*	*N/Sp*	263	..	105	..	..	..	78	..	..	183	3.96	.04
7	$30^{10}2$	263-11	*Sr/Sr*	*Sr/Sp*	271	..	63	..	..	..	..	63	..	126		
8	$30^{11}6$	271-11	*Sr/Sr*	*Sr/Sp*	277	..	70	..	..	..	..	60	..	130	0.77	.40
9	$30^{11}9$	277-11	*Sr/Sr*	*Sr/Sp*	289	..	34	..	..	..	..	40	..	74	0.48	.50
10	BH²A-4	233-13	*Sp/+*	*+/Sd*	276	..	14	11	..	..	..	..	..	25	0.36	.56
11	BH²A-2	Cp-18	*Sp/+*	*+/+*	274	..	59	23	27	..	..	..	..	109	0.88	.65

BH=Domesticated British Honduras stock of *Platypoecilus maculatus;* 30^8=Eighth inbred generation of the Mexican Rio Jamapa population; *Sp'R*=Genes for evenly scattered macromelanophores and red body coloring; *Sp*=Gene for heavy spotting, macromelanophores in small discrete clusters; *N*=Gene for the nigra pattern, a broad band of macromelanophores; *Sr*=Gene for faint macromelanophores arranged in rows; in the presence of *Sp* or *N* they cannot be distinguished; +=Recessive for sex-linked genes (or no sex-linked patterns visible); *=χ^2 determined without regard to one *N* female.

male hybrid obtained from experimen presumably (X)*Sr*/(Y)*Sp*, was mated b to the homogametic Rio Jamapa stripe-si female of stock 30 inbred for 10 generati 30^{10}, (X)*Sr*/(X)*Sr*; these results are ported in experiment 7. All the heavily bl spotted young, of which there were 63, males while the faintly striped individu of which there were 63, are females. The sults indicate that the *Sp* gene of the m hybrid was carried on the Y chromosome appeared in all of the hybrid's sons wh presumably have the same genetic const tion as their father, (X)*Sr*/(Y)*Sp*, with erence to the *Sp* gene. This may be indica as follows:

Rio Jamapa	× Rio Jamapa-Britt Honduras Hybri
P₁	
Female:	Male:
(X)*Sr*/(X)*Sr*	(X)*Sr*/(Y)*Sp*
F₁ Pedigree 271	
Daughters:	Sons:
(X)*Sr*/(X)*Sr*	(X)*Sr*/(Y)*Sp*

This sort of inheritance may be term the "father to son," or patroclinous, with spect to the spotted condition *Sp*. A sim series of results was found in the hybrid wild and domesticated platyfish, accordin Gordon (1946b).

In another experiment (8), the back-cr spotted hybrid male of pedigree number (X)*Sr*/(Y)*Sp*, was back-crossed again t Rio Jamapa female, (X)*Sr*/(X)*Sr*, to termine whether the patroclinous type of heritance could continue. It did. This t there were 70 black-spotted so (X)*Sr*/(Y)*Sp*, and 60 stripe-sided dau ters, (X)*Sr*/(X)*Sr*.

Once more a spot-sided male obtained fr experiment 8 was back-crossed to a p stripe-sided female of an inbred stock. again similar results were obtained; see c in Table 2, experiment 9. All the bla spotted fish were male, of which there w 34, and all the stripe-sided fish were fem of which there were 40.

The patroclinous type of inheritance in evidence in a series of three back-cross and no exceptions were detected.

Before passing on to a discussion of remaining two experiments in sex deter nation, it is desirable to declare that th was another purpose in making the series matings just completed beyond that of stu ing the sex-determining mechanism. Gor (1949), in a preliminary announcement, dicated that when a platyfish with a spot dorsal gene, *Sd*, from the Rio Coatzacoa population, was mated with a platyfish fr the Rio Jamapa population, of the same s cies but without the spotted dorsal patt (+) the Rio Coatzacoalcos-Rio Jam platyfish hybrids that inherited the *Sd* g developed macromelanophores in their do fins within a week after they were born. only did the macromelanophores app

arlier in these hybrids but the pigment cells ıcreased in numbers in the growing animals ar beyond the limits known in the normal io Coatzacoalcos platyfish.

The second purpose, then, in mating a potted British Honduras platyfish of the omesticated stock to a member of the wild io Jamapa population was to determine if similar change in the expressivity of the potted gene, *Sp*, could be induced. The reults obtained from experiments 6, 7, 8 and indicate that some important changes in he nature of pigment cell growth did occur h the hybrids of platyfish representing diferent geographical populations of the same pecies.

In the first generation hybrids produced experiment 6) by mating members repreenting the domesticated British Honduras nd the Rio Jamapa Mexican stocks, the spoted fish were considerably darker than either f their parents. When a spotted hybrid, 63-11, male was back-crossed to the Mexian stock (experiment 7), the spotted offpring were darker still. When a darkly spoted back-cross hybrid, 271-11, was backrossed again to the Rio Jamapa platyfish experiment 8), there was a further intensiication of pigment cell growth in their offpring. When another back-cross was made y mating a double back-cross hybrid, 277-11, o a member of the Rio Jamapa strain (experiment 9), the macromelanophores covered the bodies of the offspring completely, producing intensely black platyfish. Yet no isible pathological conditions resulted.

In order to determine the strength of the W sex chromosome for female determining actors, a mating was arranged using a spotted WY female of the domesticated British Honduras stock, and a spotted-dorsal XY male from a Rio Jamapa population, both the male and female being heterogametic with respect to the sex chromosomes. The mating (experiment 10) may be expressed as follows:

P₁

Domesticated British Honduras	Wild Rio Jamapa (Mexico)
Female (Spot-sided):	Male (Spotted dorsal):
(W)+/(Y)*Sp*	(X)+/(Y)*Sd*

Pedigree 276

F₁

11 Unspotted Daughters 14 Spotted Sons

The mating produced only *two* phenotypes although on the basis of theory there should have been four phenotypic groups to correspond with the four expected genotypes as follows:

Daughters:	Sons:
(W)+/(X)+, Unspotted	(X)+/(Y)*Sp*, Spotted sides
(W)+/(Y)*Sd*, Spotted dorsal	(Y)*Sd*/(Y)*Sp*, Spotted sides and dorsal fin

Apparently the expressivity of the Rio Jamapa platyfish gene *Sd* is reduced to zero and it does not produce a spotted dorsal pattern in the F_1 hybrids between the members of two different populations. In this connection, Gordon (1951) shows that some similar intraspecific platyfish hybrids carry the *Sd* gene but do not show the spotted dorsal pattern. When one of the unmarked (*Sd*) platyfish is mated to a swordtail, *Xiphophorus hellerii*, the platyfish-swordtail hybrids develop a melanosis of the dorsal fin, in response to a reaction between the *Sd* gene and its gene modifiers. When a platyfish-swordtail hybrid with a melanosis of the dorsal fin is back-crossed to a swordtail, some of the young of the back-cross generation develop melanomas of the dorsal fin. An explanation for the suppression of the Rio Jamapa gene *Sd* by genes of the domesticated British Honduras stock is being sought. This subject will be presented and discussed in another paper.

With respect to the reaction of the various combinations of sex chromosomes, it appears that the W of the British Honduras stock has sufficient female-determining genes to override the Y male-determining chromosome of the Rio Jamapa stock. The ratio of females to males is one to one. The consequence of inbreeding members of the hybrid 276 stock may be anticipated by experiments previously described by Gordon (1946a, 1947a). In some F_2 populations the sex ratio is one to one. In others the ratio is three females to one male.

The last experiment (11) in this series concerns the mating of a spotted member of the domesticated British Honduras stock with a recessive male member of the Rio Coatzacoalcos population. The results were quite surprising since experiment 11 was essentially the same as 10. Instead of getting equal numbers of males and females, three males were obtained for every female.

The mating may be expressed as follows:

Domesticated British Honduras	Wild Rio Coatzacoalcos (Mexico)
P₁	
Female (Spotted):	Male (Unspotted):
(W)+/(Y)*Sp*	(X)+/(Y)+

Pedigree 274

F₁

Daughters:	Sons:
23 (W)+/(X)+	27 (W)+/(Y)+
	59 { (X)+/(Y)*Sp* ; (Y)+/(Y)*Sp* }

All the spotted (*Sp*) and one-half of the unspotted fish (+) of the F_1 were male while none of the spotted and only one-half of the unspotted ones were female. The W chromosome of the BH (domesticated British Honduras) stock, in association with the Y chromosome of the Rio Coatzacoalcos population, produces males, although females were expected in view of the results in experiment 10. Apparently, then, the Y chromo-

some of the Rio Coatzacoalcos platyfish has a stronger influence in the direction of maleness than the Y of the Rio Jamapa population. This is another example of the hidden genetic differences that exist between the apparently similar platyfish of the same species but from different geographical populations, Gordon (1947b). Experiments between these and other long-isolated platyfish populations are continuing.

DISCUSSION.

The chromosomal formula for heterogametic females used here, WY, is definitive in itself. To use XY for the heterogametic female platyfish would be confusing. Taken out of context, XY may represent a normal male as well as a female. The suggestion of Castle (1936) that the homogametic male be represented by YY has been adopted, particularly because it has been shown (Gordon, 1946b) that the Z chromosome is homologous with the Y. This has been confirmed in some of the present experiments, 6, 7, 8 and 9, which indicate that father-to-son inheritance may be explained by associating the dominant gene for spotting with the Y chromosome.

The three types of sex-determining chromosomes may reflect the presence of three differing sex-determining alleles comparable perhaps to the superior sex gene of *Lebistes*, as suggested by Winge (1932). At any rate, the various chromosomes carrying strong genes for sex are: W for strong femaleness, X for femaleness and Y for maleness. This, of course, is probably an oversimplification of the real conditions. On the whole, Winge's (1934) interpretations, a modified view of Bridges' (1932) theory of genic balance, may be applied to the data obtained with *Platypoecilus*. From his experiments in the field of genetic mechanism for sex determination in *Lebistes*, Winge (1934) and Winge & Ditlevsen (1947) assume that female and male sex-determining genes are distributed over a great many of the autosomes, with superior sex genes in the sex chromosomes. Winge further assumed that, in some individuals, the role of decision with respect to sex may be shifted to the autosomes.

By various systems of selective mating and inbreeding, Winge obtained XY females and XX males, despite the fact that in the guppy the females are normally XX and the males XY. He explains that XY females probably contain many autosomal sex genes which pull strongly in the female direction and in spite of the presence of the Y chromosome, the fish develops as a female. Conversely, the exceptional XX male probably has many autosomal sex genes pulling effectively in the male direction. The first exceptional XX type, once obtained, was recovered after repeated backcrossing. The original XX male was mated to one of its daughters, then to one of its granddaughters and then to one of its great-granddaughters. Obviously, this system of mating involving back-crossing and inbreeding, or some modification of it, could hardly be effective in a natural population in a state of panmixia. For example, Winge & Ditlevsen (1947) report that the normal sex-determining mechanism, XX female, XY male, is reestablished quickly in an aquarium population when the exceptional types, XY females and XX males, are out-crossed:

Female:	P_1	Male:
(X)+/(Y)*Ma*	×	(X)*Li*/(X)*Li*
32 Females:	F_1	35 Males:
(X)+/(X)*Li*		(X)*Li*/(Y)*Ma*

The opposing autosomal sets of sex genes from XX males and XY females apparently balance each other, so that the sex-determining mechanism is again dependent upon the usual X and Y chromosomes, and the male and female offspring are XY and XX respectively.

At best, the exceptional *Lebistes* XX males and XY females are precariously balanced with regard to the sum total of their sex genes. According to Winge, the sex ratio of the offspring produced by mating XX males with XX females is influenced by the season. For example, during the month of April the broods contained almost an equality of the sexes; other times XX males and XX females produced a preponderance of females. Winge & Ditlevson (1947) obtained a sum total of 851 females to only 26 males from many matings over a period of a year. Previously Winge (1934) reported 242 females to 45 males in one series, and 102 females to 45 males in another. From these results he suggested that there is no reason to assume that the pair of deciding autosomes are the same in the two series of XX male *Lebistes*.

In an attempt to identify which specific pair of autosomes in *Lebistes* has become "the new sex-determining chromosomes" in XX males, Winge failed in a number of experiments to associate the new sex mechanism to the autosomal pair carrying the *zebrinus* gene. Winge & Ditlevsen failed, in further experiments, to associate the new mechanism to other known autosomal pairs that carry color genes, of which there are only a few. *Lebistes* has 22 autosomal pairs of chromosomes and one pair of sex chromosomes, or a total of 46 chromosomes.

The conclusions which may be reached from the data on *Lebistes*, as far as they are related to the results from *Platypoecilus* are: 1. Female and male sex-determining genes are probably distributed over a great many of the autosomes with superior sex genes in the sex chromosomes. The superior sex genes may, in exceptional individuals, be overridden by many autosomal genes with small effects upon sex determination. This may have been the situation in the one XX male platyfish discovered genetically by Gordon (1946a, 1947a) and described histologically by Gordon & Aronowitz (1951). 2. It is unlikely that a pair, any one pair, of autosomes can take over the role of the sex chromosomes in any considerable number of individuals in wild populations in a state of panmixia. 3. It is extremely doubtful that

he switch mechanism by which exceptional XX male and XY female *Lebistes* are produced in the laboratory is the same as the one which produced homogametic male and heterogametic female platyfish in natural populations. Indeed, it may be that female heterogamety arose first in the platyfish of British Honduras and later its isolates, such as populations in Mexico, developed male heterogamety secondarily by a process as yet unknown.

The genetic results obtained from the domesticated strain of platyfish originally taken from British Honduras may best be explained on the basis of assuming that the females are heterogametic and the males homogametic for the deciding genes for sex determination. At first there was considerable doubt with regard to the origin of this strain since in a commercial establishment such as the Everglades Aquatic Nurseries there is a constant shifting of stocks and there is always a possibility of mixing them. A further doubt arose when no comparable color variety of the "salt-and-pepper" platyfish was found in our collection from the Belize River which was taken in 1949 within ten miles of the city of Belize in British Honduras. Nevertheless, after testing the "wild" Belize River platyfish, Gordon (1950) announced that they, too, have a genetic sex-determining mechanism in which the females are heterogametic and the males homogametic. New data, as yet unpublished, revealed that when a Belize River male platyfish was mated to a Rio Jamapa female they produced 65 young, all of which were male. In another similar mating, 240 offspring were obtained of which 239 were male. Since it was previously shown by Gordon (1947a) that the Rio Jamapa platyfish females are homogametic, XX, this is convincing proof that the wild Belize River male platyfish are homogametic with respect to their sex-determining chromosomes, YY.

In an organism which has a stable sex-determining mechanism, and *Platypoecilus maculatus* has such a mechanism despite statements to the contrary, the sex of the individual must be determined at conception. Environmental influences in organisms of this type play a minor role in altering the genetic sex of the individual. This is subject to test. The mating of an XX female with a YY male produced 183 offspring, all of which were male, experiment number 6, Table 2. The sex of these 183 young was determined in a natural way, that is, they were grown to maturity and all of them developed into males at about six months to one year. All of them developed typical gonopodia and other indisputable characters of the male sex. The Rio Jamapa female platyfish that produced them continued to have more young. Forty of these were taken, some when only one day old, others when 28 days old, 73 days old, and so on. None of the young showed any definitive secondary sexual characters externally. They were fixed and their gonads studied. The sex of all of them was determined histologically. All of them had testes, none had any ovarian elements. Thus they were males as far back in their development as histological methods can reveal. The details of this study may be found in the succeeding paper by Chavin & Gordon (1951).

SUMMARY.

1. The domesticated strain known as the "salt-and-pepper" platyfish, *Platypoecilus maculatus*, is allegedly derived from wild platyfish obtained from British Honduras. The fish carry the following sex-linked genes for color patterns: *Sp* for strong macromelanophore spotting; *Sp'* for weak macromelanophore spotting; *R* for erythrophore red coloring of the entire body; *N* for black bands of macromelanophores.

2. The genetic behavior of the sex-linked gene reveals that this stock of platyfish has a type of mechanism for sex determination in which the females are heterogametic, or WY, and the males are homogametic, or YY.

3. When a homogametic male of the domesticated stock from British Honduras, YY, is mated with a homogametic female from the Rio Jamapa in Mexico, XX, all their progeny are male, XY. The genetic mechanism for sex determination in each of these two stocks is stable.

4. The Y chromosome of platyfish from Rio Coatzacoalcos, Mexico, contains stronger sex genes for maleness than the Y of the platyfish of the Rio Jamapa population.

5. There is no evidence that heterogametic male—homogametic female genetic mechanism for sex determination was transformed to the homogametic male—heterogametic female mechanism by the shift of potent sex genes to autosomes, such as has been suggested to account for the development of XX males and XY females in *Lebistes*.

6. The macromelanophores of the domesticated British Honduras platyfish are sensitive to macromelanophore-modifying genes present in the Rio Jamapa platyfish population. The growth of the large black pigment cells is accelerated in their spotted hybrids, but no pathological conditions in them have yet been detected.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. The three types of *Platypoecilus maculatus* of pedigree number BH2 obtained from the mating of a pair of "salt-and-pepper" domesticated strain of platyfish originally from British Honduras. The heavily-spotted parents looked like the daughter shown uppermost in the figure and the son which is to the extreme right. The two original, heavily-spotted parent color types were recovered. Another type of daughter appeared which was faintly spotted and reddish in color; it is at the extreme left in the figure. The sex ratio obtained from the mating of a pair of "salt-and-pepper" platyfish is as follows: strongly spotted males, *Sp*, 50%; strongly spotted females, *Sp*, 25%; faintly spotted and reddish females, *Sp'R*, 25%. The sex ratio is one to one.

This and the other photographs of living fishes (life size) were made by S. C. Dunton, Staff Photographer, New York Zoological Society.

Fig. 2. Lower: a female platyfish, *Platypoecilus maculatus*, genetically XX, from the Rio Jamapa population in Mexico. Upper: representative male platyfish of the same species developed in a commercial tropical fish hatchery from a "salt-and-pepper" stock originally obtained from British Honduras; genetically the males are YY.

PLATE II.

Fig. 3. The two types of males produced b mating a platyfish male of the commer cial stocks originally from Britis Honduras, genetic constitution (Y)*S* /(Y)*N*, with a female platyfish fron the Rio Jamapa, genetic constitutio (X)*Sr*/(X)*Sr*. The entire brood, pedi gree number 263, was composed o males; see Table 2. The black or nigra (X)*Sr*/(Y)*N*, male is shown abov and the spotted male, (X)*Sr*/(Y)*S* is shown below.

Note the greater intensity of macro melanophore pigmentation in the prog eny.

Fig. 4. The three types of platyfish of pedi gree number 274 obtained from matin a spotted female member of the do mesticated British Honduras stock t an unspotted male from the wild popu lation of the Rio Coatzacoalcos, Mexi co. The sex ratio obtained is as follows strongly spotted males, *Sp*, 50% (top) unspotted males, + 25% (left); un spotted females, + 25% (right); o three males to one female. Note th greater intensity of macromelanophor pigmentation in the spotted Britis Honduras-Mexican male hybrid show here than in the spotted male of th straight domesticated British Hon duras stock which is shown in Figur 1; also see Text-figure 1.

FIG. 1.

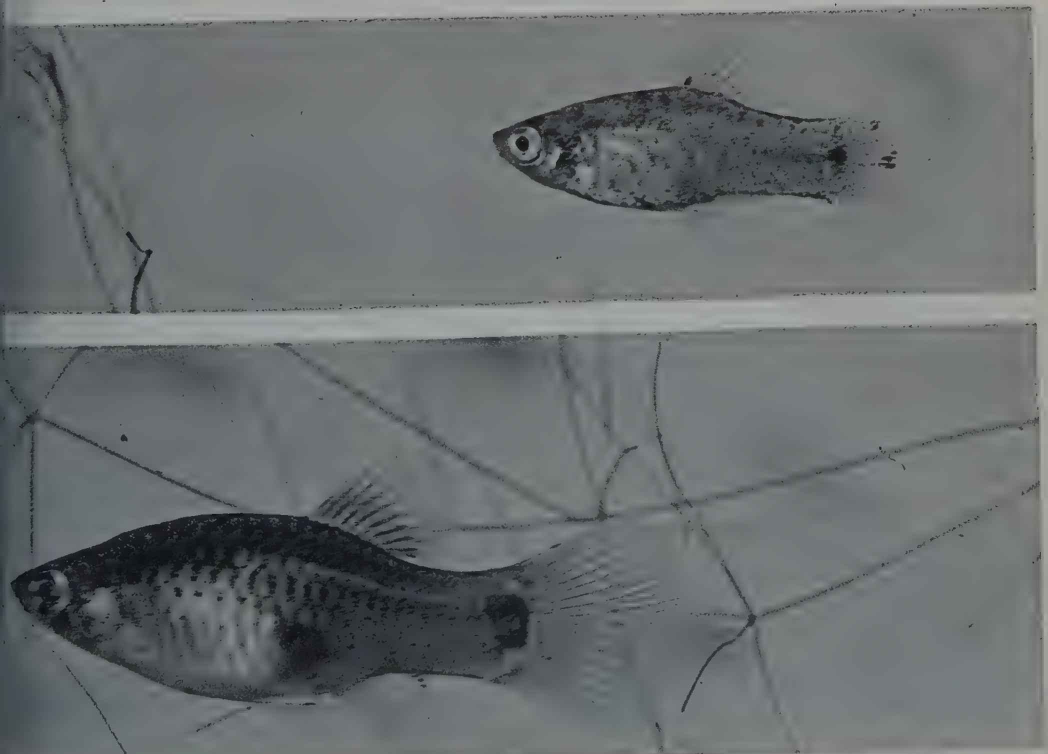

FIG. 2.

GENETICS OF PLATYPOECILUS MACULATUS. V.

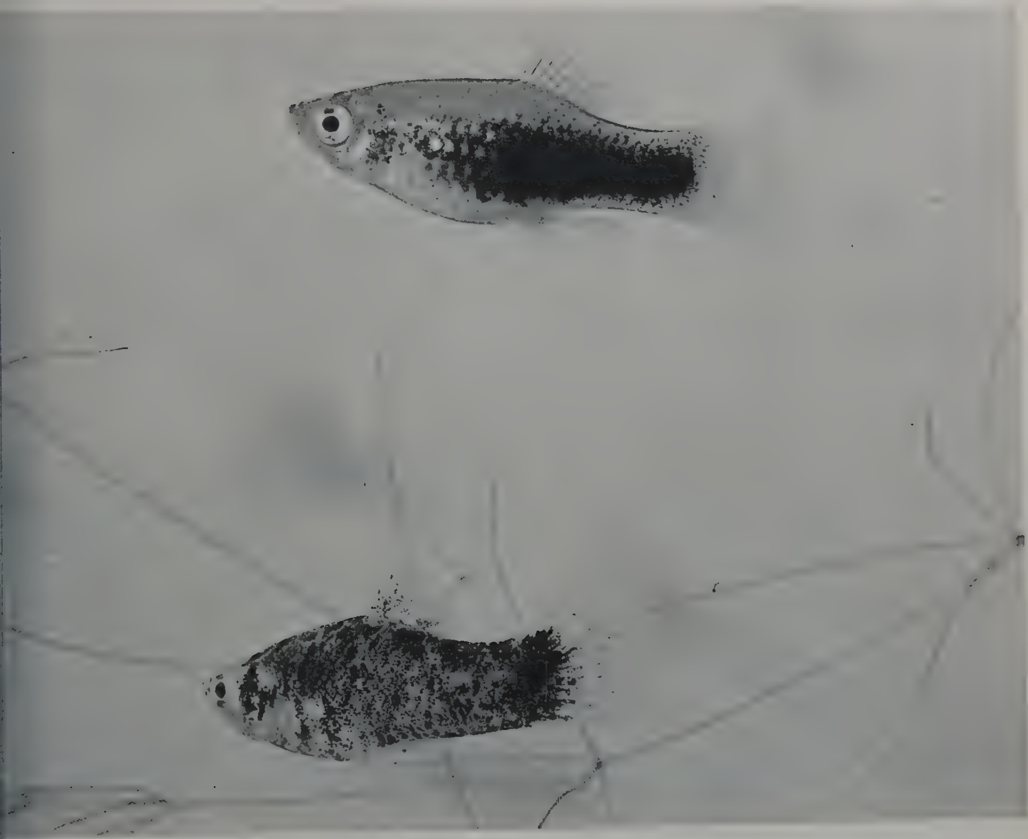

FIG. 3.

FIG. 4.

GENETICS OF PLATYPOECILUS MACULATUS. V.

8.

Sex Determination in *Platypoecilus maculatus*. I. Differentiation of the Gonads in Members of All-male Broods.[1]

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(Plates I-IV; Text-figures 1-3).

In the course of studying the sex-linked inheritance of macromelanophores in various strains of the viviparous platyfish, *Platypoecilus maculatus*, two females were found producing large numbers of offspring all of which were male. A genetic mechanism for sex determination was known which could explain the results obtained. For example, Gordon (1946) indicated that when a male platyfish of domesticated stocks is mated with a female of wild-caught stocks from Mexico, all the young are male. It was explained that domesticated stocks have a type of genetic mechanism for sex determination in which the female is WY and the male is YY, while in the wild stocks from Mexico the female is XX and the male is XY. Thus when an XX female is mated with a YY male, all the young are XY, and male.

If the suggested chromosomal mechanism for sex determination is valid when applied to the male-producing females, it was thought that a histological study of the developing gonads of the offspring should reveal the presence of testicular anlagen in the extremely young and definitive testes in the older members of the all-male broods. This paper reports the histological results obtained.

As the studies progressed it was found that the material was suitable to show the relationship of the various stages in the development of the testes to corresponding stages in the transformation of the male's anal fin into the highly complex gonopodium, the fin which serves to transfer the spermatophores from the male to the genital aperture of the female. In the platyfish fertilization is internal and the females produce about 40 living young at intervals of about 28 days.

There was an opportunity also to study the relationship of the stage of development of the gonad to the age, size and genetic constitution of the fishes.

MATERIAL AND METHOD.

A female member (30^{8}-5) of an inbred (eighth generation) wild population of *Platypoecilus maculatus* originally from the Rio Jamapa, Veracruz, Mexico, was mated to the so-called "salt-and-pepper" male platyfish (BH-14) of a commercial stock obtained from the Everglades Aquatic Nurseries of Tampa, Florida.

The wild Rio Jamapa platyfish of stock 30 is characterized by being homozygous for the dominant striped gene *Sr*. This gene controls macromelanophores which form a series of faint but distinct rows of large black pigment cells on the sides.

The commercial "salt-and-pepper" platyfish is heavily spotted with macromelanophores. Ordinarily this stock carries the dominant gene *Sp* either in a homozygous or heterozygous state. Occasionally a member of this commercial stock also carries the dominant *N* gene, for macromelanophores arranged in a black-banded pattern. The male used, BH-14, phenotypically appeared to be *Sp*+, but actually was *SpN*, according to the results observed, Gordon (1951). The sex-linked genes, *Sr, Sp* and *N*, are members of an allelic series, according to Gordon (1948).

The genetic sex-determining mechanism of the Rio Jamapa platyfish was known to be XX female, XY male, from the work of Gordon (1947). The genetic analysis of the "salt-and-pepper" platyfish stock was in progress. It is now quite clear that this stock has the "domesticated" type of sex determination; that is, the WY female and YY male. This type, WY-YY, has recently been discovered in a natural population of *P. maculatus* from the Belize River in British Honduras, according to the announcement of Gordon (1950a).

The mating between platyfish of differing stocks may be expressed as follows:

1 From the Genetics Laboratory of the New York Zoological Society at the American Museum of Natural History, New York City. The animals used in this study were obtained from work being done under a grant to the New York Zoological Society from the National Cancer Institute, National Institutes of Health of the U. S. Public Health Service for the project: Genetic and correlated studies of normal and atypical pigment cell growth. The authors wish to thank Dr. Olga Aronowitz for reading the manuscript.

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3 This paper is based upon a thesis presented to the Graduate School of Arts and Sciences of New York University by the first author, in partial fulfillment for the degree of Master of Science.

P_1

Rio Jamapa Female	Salt-and-Pepper Male
(30^8-5)	(BH-14)
Striped-sided	Spotted, Black-banded
(X)*Sr*/(X)*Sr*	(Y)*Sp*/(Y)*N*

F_1 (Pedigree No. 263)

(X)*Sr*/(Y)*Sp*:
105 males, Spotted ("salt-and-pepper")

(X)*Sr*/(Y)*N*:
78 males, Black-banded

Every one of the 183 F_1 platyfish in the brood reared to maturity by routine methods of laboratory maintenance was a male. Female 30^8-5 continued to produce young and 40 of them (20 with spotted patterns and 20 with the black-banded patterns) were selected at varying ages and fixed in Bouin's fluid for histological study of their gonads. In addition female 30^8-5, when gravid again, at a later period, was sacrificed and 38 embryos in late stages of development were recovered from its ovary. All the embryos were examined carefully and were found normal; 13 of them were fixed, sectioned and studied histologically.

The genetic constitution of the second male-producing female, 239-1, can not be stated with precision, owing to the fact that it was obtained from a long series of matings involving both wild and domesticated stocks. This is also true of the male, 205-11, with which it was mated. In checking their genetic history it is probable that the female parent was XX and the male YY. Together they produced platyfish of brood No. 260, all 41 members of which were males. Eighteen of them were fixed in Bouin's fluid for histological study of their gonads.

After fixation, all the fishes were decalcified, dehydrated in dioxane, imbedded in paraffin and sectioned serially at eight microns. The sections were variously stained with Heidenhain's iron hematoxylin, Harris' alum hematoxylin, eosin and Heidenhain's modification of Masson's trichrome stain.

Before sectioning the fish, the condition of their anal fin was recorded. The standard length of each specimen was measured from the tip of the snout to the end of the caudal peduncle. The depth of the body, from the first ray of the dorsal fin to the first ray of the anal fin, was also measured, after which the body index was determined by dividing the value of the standard length by the value of the depth of the body. These measurements were recorded in tabular form, Tables 3 and 4. After sectioning, the stage of gonadal development of each animal was determined. These details are also included in Tables 3 and 4.

The culture methods used in the care and breeding of the platyfish are described in detail by Gordon (1950b).

The Development of the Gonad.

Introduction.

Wolf (1931) indicated that sexual differentiation in the platyfish may be detected histologically in embryos 6.0 to 6.5 mm. in length. Embryos having two hundred or more germ cells in the gonad are likely to be female; those having one hundred or less are probably male. He pointed out that a more reliable set of criteria is available for distinguishing the two sexes in slightly older just born platyfish.

In 6 to 7 mm. early postnatal female platyfish, the germ cells, which have multiplied and enlarged to two or three times their original size, are distributed throughout the body of the primitive gonad. The stroma cells that surround the developing oögonia initiate the formation of the follicles.

In comparable 6 to 7 mm. postnatal male fish, the germ cells are distributed at the periphery of the gonad primordia; the center of the testis is occupied by stroma cells. In slightly older fishes the centrally located stroma cells cluster together to form the beginnings of the sperm duct.

These histological details of the differentiating gonads were utilized, in part, in the determination of the sex of the fishes under discussion.

The Undifferentiated Gonad.

Embryos.

Thirteen embryos in their fourteenth day of intra-ovarian development were studied.

They have small, widely separated gonad primordia consisting of undifferentiated mesodermal cells and primordial germ cells which are distributed throughout the gonad rudiment. The germ cells are oval and measure 8 to 13 microns (Pl. I, Fig. 1). Their cellular membranes are distinct and the cytoplasm is homogeneous except for the presence of occasional fine basophilia. Their nuclei at rest, which measure 5 to 9 microns, are almost spherical and their membranes stain deeply with hematoxylin. The chromatin granules are distributed throughout the nucleus but are more concentrated near the periphery. Each nucleus usually has one nucleolus, rarely two.

The mesodermal cells or stroma cells have no distinct cellular membranes. Their nuclei are characterized by being elliptical, and small, 3 to 4 microns, and each contains an irregular and coarse reticulum.

The gonad primordia are surrounded by peritoneal cells which are fusiform, have distinct cellular membranes and contain elliptical nuclei which are similar in size and structure to those of the stroma cells.

Early Postnatal Fish.

Six platyfish at birth, measuring 5.6 to 6.0 mm., were studied.

They have paired gonads which are larger and closer together than the two gonadal primordia of embryos. The primordial germ cells are found throughout the undifferentiated gonad.

The Development of the Testis.

Stage 1.

Nine platyfish, measuring 8.7 to 12.9 mm., were studied.

They have paired gonads which lie close ogether and are surrounded by a thin, simle, squamous, peritoneal membrane. The erm cells appear singly or in small groups t the periphery (cortex) of the gonad hich, for the most part, is composed of troma cells (Pl. I, Fig. 2). As indicated by Volf, this peripheral distribution of the erm cells in platyfish of this size is indicaive of a testis.

tage 2. Spermatogonial Acini.

Nine platyfish, measuring 9.5 to 21.0 mm., ere found in this stage of gonadal developent.

They have paired gonads which have beun to fuse. An increasing number of germ ells are distributed about the periphery of he gonad in a discontinuous layer. There hey form small groups or acini. Each acinus ontains up to eight germ cells and these cells nay now be referred to as spermatogonia Pl. I, Fig. 3). The spermatogonial cells are pproximately 5 to 6 microns in diameter and heir nuclei are 3 to 4 microns. These cells, xcept for size, are similar to those of the rimordial germ cells.

Some of the stroma cells, which are the najor components of the developing testes, re grouped to produce a large sperm duct n each testis (Pl. IV, Fig. 11). The two lucts are fused posteriorly.

Stage 3. Numerous Spermatogonial Acini.

Ten platyfish, measuring 10.5 to 21.0 mm., were studied and found to be further advanced in their gonadal development.

The gonads are still only partially fused. A larger number of spermatogonial cells and acini form a thick cortex at the periphery of the gland (Pl. I, Fig. 4).

The proliferated stroma cells form a series of primary sperm ducts and a number of smaller branches or tubules. When viewed in cross-section these arborescent structures resemble a series of rings (Pl. I, Fig. 4).

Stage 4. Primary Spermatocytes.

Four platyfish, measuring 13.5 to 18.7 mm., were found to be in the fourth stage.

They have gonads in all parts of which are found a large number of spermatogonial acini, and an increasing number of acini that contain primary spermatocytes (Pl. II, Fig. 5). The interkinetic nuclei of the primary spermatocytes are spherical, measure approximately 3.5 microns, and each contains a coarse reticulum with several large chromocenters. The cellular membranes of the primary spermatocytes are not sharply defined.

The sperm ducts are larger and their branching tubules are more numerous. Some of them may extend almost up to the periphery of the testis.

Stage 5. Secondary Spermatocytes.

Nine platyfish, measuring 12.0 to 29.0 mm., were in this stage of development.

They have gonads which have completely fused, although the line of fusion is clearly visible. The acini are very numerous. Some of them contain spermatogonial cells, others contain primary spermatocytes, and some, secondary spermatocytes. The germ cells within a given acinus are all at the same spermatogenic stage. The primary and secondary spermatocytes are similar in appearance. There are twice as many secondary as primary spermatocytes in each acinus and their nuclei are half as large, about 2 microns. The acini which contain the secondary spermatocytes lie nearer the center of the testis than do the other types of acini. These acini develop in a lineal series, or cord, which is characteristic of this stage (Pl. II, Figs. 6 & 7).

The acini are encapsulated by a thin membrane of differentiated stroma cells. These cells are slender and elongate; their large, bulging nuclei are elliptical, 6 to 8 microns in diameter, and each contains a nucleolus.

Stage 6. Spermatophores.

Eleven young adults, measuring 15.1 to 26.8 mm., had large fused testes.

The testis is a single organ but its bipartite origin is clearly in evidence, for the two parts are unequal in size, the left lobe being larger than the right. It occupies a considerable area of the visceral cavity. The testis lies medially and is suspended beneath the swim bladder by a short mesorchium. It is covered by a thin, unpigmented peritoneal membrane.

The secondary spermatocytes within their acini first transform into spermatids and these, in turn, transform into spermatozoa. The heads of the spermatozoa, which measure 0.8 by 3.0 microns, are arranged peripherally within each acinus which now becomes a spermatophore (Pl. III, Fig. 8). The latter are 37 to 54 microns in diameter. The spermatophores within the germinal portion of the testes are surrounded by Sertoli cells (Pl. III, Fig. 9) which are characterized by the following: Their cellular outlines are indeterminable but their oval nuclei are large, about 7.5 microns, and each has a nucleolus. The nuclear membrane is distinct and encloses a clear karyolymph in which chromatic granules of varying sizes are irregularly distributed. The Sertoli cells are not found about the spermatophores after they enter the sperm duct. Medlen (1950) found the Sertoli cells in *Gambusia* before but not after the spermatophores pass into the lumen of the testicular canal.

The Release of Spermatophores.

The spermatophores pass along the branches of the sperm duct to the center of the testis where the two large ducts are fused and form a common, ciliated and tubular chamber, the so-called vas deferens (Pl. III, Figs. 8 & 10). The tissue about the wall of the caudal region of the sperm duct is thickened considerably, forming a genital papilla at its terminus. The duct opens at the apex of the genital papilla which, in turn,

projects into the uro-genital sinus. Just anterior to the genital papilla the sperm duct is surrounded by a smooth muscle sphincter which may be a part of the ejaculatory apparatus. Ventral to the sperm duct or genital sphincter and the genital papilla, a dense, fibrous connective tissue structure, in the shape of a shallow trough, lies for its entire length between the sperm duct and the terminal portion of the alimentary canal. This partition effectively separates the digestive system from the urinary and genital systems and extends to separate the anus from the urino-genital apertures (Pl. IV, Fig. 12).

Interrelationships Among Age, Length, Maturation of Testis and Gonopodium.

A summary of the various stages in the differentiation of the testis is given in Table I. In Table II the characteristic features of various developmental stages of the gonopodium are listed. The age, length, depth and the developmental stages of the gonopodia and testes of the fish of brood 260 are given in Table III and those of brood 263 are given in Table IV A, B.

Three product moment correlations, expressed as the coefficient r, were performed in order to determine the relationships, if any, among the values for the age, the standard length, the developmental stage of the testis and the developmental stage of the gonopodium of the male platyfish in 40 fish of brood 263. The measurement and developmental stages are given in Table IV; see also Text-figs. 1, 2 and 3.

Each value for r was transformed to the normally distributed coefficient z in order to increase the reliability of the calculations.

The first correlation coefficient was derived from a comparison of the ages of the fishes with their standard lengths. It is quite high, $r = +0.90$ and $z = +1.47 \pm 0.16$. The result obtained is what would be expected if there were no significant errors of sampling nor important variations in the environmental conditions under which the fish were kept. Under uniform conditions and similar genetic constitutions it may be said that the standard length of a fish increases in proportion to its advancing age.

The second series of calculations was made to obtain a comparison of the standard length of the platyfish with the developm-

TABLE 1.

Stages in the Differentiation of the Testis of *Platypoecilus maculatus*.

Stage 1: Primordial Germ Cells.	a. Two small, separated gonad primordia.
	*b. Gonad primordia largely composed of stroma.
	*c. Primordial germ cells discrete or in very small groups at the periphery of testis.
	d. No ducts present.
Stage 2: Spermatogonial Acini Few.	a. Testis distinctly bipartite.
	*b. In each primordium some stroma cells form one large duct.
	c. Much stroma still present.
	*d. Germ cells (spermatogonia), at the periphery of gonad primordia; not more than eight cells in small acini.
Stage 3: Spermatogonial Acini Numerous.	a. Testis somewhat less bipartite.
	*b. Appearance of many branching ducts.
	c. Stroma is greatly reduced.
	*d. Large number of germ cells (spermatogonia) in each of many acini.
Stage 4: Primary Spermatocytes.	a. Testis somewhat less bipartite.
	b. Ducts somewhat larger in size.
	c. Little stroma present.
	*d. Acini contain primary spermatocytes; comparatively few acini contain spermatogonia.
Stage 5: Secondary Spermatocytes.	a. Testis enlarged greatly.
	b. Sperm ducts more advanced.
	c. Little stroma present.
	*d. Cords of primary and secondary spermatocyte acini present; spermatids appear.
Stage 6: Spermatophores.	a. Fused gonad barely shows bipartite origin.
	b. Sperm ducts completely differentiated.
	c. Cords of acini numerous.
	*d. Spermatophores present in sperm ducts and tubules.

* Indicates the key characters.

TABLE 2.

Stages in the Development and Differentiation of the Gonopodium of *Platypoecilus maculatus*.

STAGE 1: Juvenile Phase.	Unmodified anal fin composed of nine pairs of fin rays.
STAGE 2: Preliminary Phase.	Thickening of the third ray of the anal fin. The beginning of the bifurcation of rays three and four.
STAGE 3: Growth Phase.	Elongation of rays three, four and five. Nine to ten segments in the third ray.
STAGE 4: Differentiation.	a. The appearance of a subdermal thickening. b. The appearance of the proximal serrae. c. The appearance of the distal serrae. d. The appearance of a blade over the hook.
STAGE 5: Completion.	Tip of gonopodium fully segmented and differentiated.

mental stage of its testis. The correlation coefficient is high, $r = +0.94$ and $z = +1.74 \pm 0.16$.

The third correlation coefficient was evaluated in order to determine the degree of association between the paired values for the standard lengths of the fish and the developmental growth and differentiating stages of their gonopodia. The result shows a high correlation, $r = +0.87$ and $z = +1.33 \pm 0.16$.

Summing up these correlations, it may be said that as the age of the platyfish increases, its standard length increases proportionately. As the standard length increases, the developmental stages of the testis advance. At the same time as its standard length increases, its anal fin develops in a successive series of stages to form the gonopodium (Text-fig. 1).

Brood 263 consisted of males of two genotypes. About half had the sex-linked gene *Sp* for macromelanophores irregularly arranged on the body, while the others had an allele *N* for large black pigment cells arranged in the form of a black band. A comparison was made between the two kinds with respect to their rate of growth (that is, age with reference to standard length) and to the rate of development of their testes and gonopodia. No significant differences between the two groups were found. The data are given in Table IV C.

DISCUSSION.

The maleness of 71 platyfish out of 262 males of two broods was determined, in part, by histological studies of the gonads of the youngest members. Only testicular elements were found in all except the embryos and in the latter the gonads were indifferent. No ovarian structures were ever found. This is in contrast to the situation in some sword-

TABLE 3.

Measurements of *Platypoecilus maculatus* of Culture 260 Arranged in Regard to the Developmental Stage of Their Gonads.

Animal	Standard Length (mm.)	Standard Depth (mm.)	Body Index[1]	Stage of Gonopodium Development[2]	Stage of Testicular Development[3]
260- 1	10.8	3.5	3.1	1	1
260- 3	12.9	3.2	3.2	1	1
260- 4	12.9	4.5	2.9	2	1
260- 5	11.5	3.8	3.0	1	2
260- 6	11.6	3.8	3.1	1	2
260- 2	11.9	3.9	3.1	1	2
260- 7	18.2	6.0	3.0	2	3
260- 8	19.0	6.3	3.0	2	3
260-17	21.0	8.0	2.6	2	3
260- 9	18.7	6.7	2.8	2	4
260-10	21.9	7.9	2.8	3	5
260-18	22.0	8.0	2.7	3	5
260-15	25.1	9.5	2.7	5	5
260-12	29.0	11.0	2.6	5	5
260-16	22.5	8.5	2.6	3	6
260-14	23.0	8.0	2.9	4	6
260-11	24.0	8.5	2.8	5	6
260-13	26.8	9.5	2.8	5	6

Number of animals = 18.

[1] Value of standard length divided by the value of the standard depth.
[2] Regrouped from Table II.
[3] Regrouped from Table I.

TABLE 4A.

Measurements of Two Genetically Different Groups of Male Siblings of *Platypoecil[us] maculatus* of Culture 263 Arranged in Regard to the Developmental Stage of Their Gona[ds]

A. Platyfish with Macromelanophores forming Black Bands (*N*).

Animal	Standard Length (mm.)	Standard Depth (mm.)	Body Index[1]	Stage of Gonopodium Development[2]	Stage of Testis Development[3]	Age (Days)
263-23	5.5	1.3	4.2	*	*	1
263-24	5.5	1.3	4.2	*	*	1
263-22	6.0	1.3	4.6	*	*	1
263-37	8.7	2.7	3.2	1	1	28
263-35	9.5	3.0	3.2	1	1	28
263-36	11.2	3.8	2.9	1	1	28
263-18	9.5	3.0	3.2	1	2	50
263-10	12.9	4.0	3.2	1	2	73
263-34	14.3	4.5	3.2	1	2	137
263- 5	13.8	4.5	3.1	2	3	109
263-17	12.0	3.5	3.4	2	3	50
263-16	13.5	4.5	3.0	2	3	50
263-11	14.5	4.8	3.0	2	3	73
263-12	14.5	4.9	3.0	2	3	73
263- 6	14.0	4.7	3.0	2	4	109
263-32	16.7	5.2	3.2	2	4	137
263- 4	16.5	5.8	2.9	3	5	109
263-33	18.0	5.4	2.8	4	6	131
263-27	18.0	7.6	2.8	5	6	131
263-28	18.5	6.5	2.8	5	6	131

Number of animals = 20.

[1] Value of standard length divided by the value of the standard depth.
[2] Determined by Table II.
[3] Determined by Table I.
* These sexually undifferentiated animals were not included in the correlation studies.

TABLE 4B.

Measurements of Two Genetically Different Groups of Male Siblings of *Platypoecilus maculatus* of Culture 263 Arranged in Regard to the Developmental Stage of Their Gonad[s]

B. Platyfish with the Macromelanophores Scattered (*Sp*).

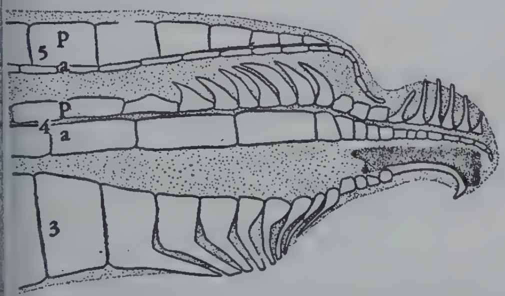
Animal	Standard Length (mm.)	Standard Depth (mm.)	Body Index[1]	Stage of Gonopodium Development[2]	Stage of Testis Development[3]	Age (Days)
263-20	5.5	1.3	4.2	*	*	1
263-19	6.0	1.3	4.6	*	*	1
263-21	6.0	1.5	4.0	*	*	1
263-40	8.8	2.8	3.1	1	1	28
263-38	9.3	3.1	3.0	1	1	28
263-39	9.8	3.0	3.3	1	1	28
263- 8	11.8	3.8	3.1	1	2	73
263- 9	12.0	3.2	3.7	1	2	73
263- 7	13.2	4.2	3.1	1	2	73
263-13	10.5	3.5	3.0	1	3	50
263-14	11.3	4.8	3.0	1	3	50
263- 1	13.5	4.5	3.0	2	4	109
263-15	12.0	4.5	2.7	2	5	50
263- 2	15.5	5.5	2.8	3	5	109
263-29	15.5	4.8	3.0	3	5	137
263- 3	16.0	5.8	2.8	3	5	109
263-26	16.7	5.8	2.8	4	6	131
263-31	17.0	5.4	3.1	4	6	137
263-30	15.1	5.0	3.0	5	6	131
263-25	17.0	6.0	2.8	5	6	131

Number of animals = 20.

[1] Value of standard length divided by the value of the standard depth.
[2] Determined by Table II.
[3] Determined by Table I.
* These sexually undifferentiated animals were not included in the correlation studies.

ails, *Xiphophorus hellerii,* and in some gup- ies, *Lebistes reticulatus.* According to Freiss 1933), Regnier (1938) and Dildine (1936), ome males of these species when very young ave ovarian elements which later degener- te and a normal testis develops.

The maleness of the 256 playfish of two roods was apparently determined geneti- ally. This may be explained by the peculiar enetic constitutions of the parents of the wo broods. The female parents had two X hromosomes, or XX, and the male parents ad two Y chromosomes, or YY. All their ffspring had XY and were male. The two ll-male broods analyzed here are only a few f many which have been observed.



TEXT-FIG. 1. Fully differentiated distal tip of the gonopodium of *Platypoecilus maculatus.* The ays are numbered 3, 4 and 5. The letters *a* and refer to the anterior and posterior halves of ays 4 and 5. The biramous parts of ray 3 have used to produce the strongest element in the gonopodium. At the extreme distal tip, the ele- nents of 4*p* are distal serrae; those of 4*a* form he ramus. The curved terminal element of ray 3 is the hook, the main element of the holdfast mechanism of the gonopodium. Above the hook s the blade which is shown in darker stippling. From Gordon & Rosen (1951).

From studies of maturation of the male platyfish, the following is our interpretation of the method of transport and ejaculation of the spermatophores. When first formed they lie in the germinal portion of the testis. They contain spermatozoa which are ar- ranged peripherally with their heads sur- rounded by Sertoli cells. The spermatophore is encapsulated by a thin membrane derived from stroma cells. This confirms Wolf's ob- servations, and a similar arrangement was described in the guppy by Goodrich, Dee, Flynn & Mercer (1934). Upon entering the sperm tubules the spermatophores are con- veyed by the ciliary action of epithelial cells to the sperm duct terminus. Here they await ejaculation, which is effected when the geni- tal sphincter is opened. The spermatophores then pass the terminal opening of the sperm duct at the apex of the genital papilla to the exterior.

TABLE 4C.

Comparison of Morphological Measurements and Developmental Features in Two Geneti- cally Different Groups of Male Siblings of Brood 263 of *Platypoecilus maculatus*, Each Group Consisting of 20 Members[1].

Character:	χ^2	n
Standard Length	7.5	3
Depth	3.4	2
Testicular Development	3.2	2
Gonopodial Development	5.0	2

[1] These calculations were made from comparison of the data in Tables IV A and B.

The transformation of the male platyfish's anal fin into the gonopodium has been de- scribed in detail by Grobstein (1940). In the present study the various developmental stages of the gonopodium follow in sequence the developmental stages of the testis. These, in turn, follow directly with increasing age and size of the individual. Similar direct cor- relations have been noted in *Xiphophorus hellerii* by Van Oordt (1925), in *Gambusia* by Dulzetto (1933) and Turner (1941), and in *Lebistes* by Samokhvalova (1933).

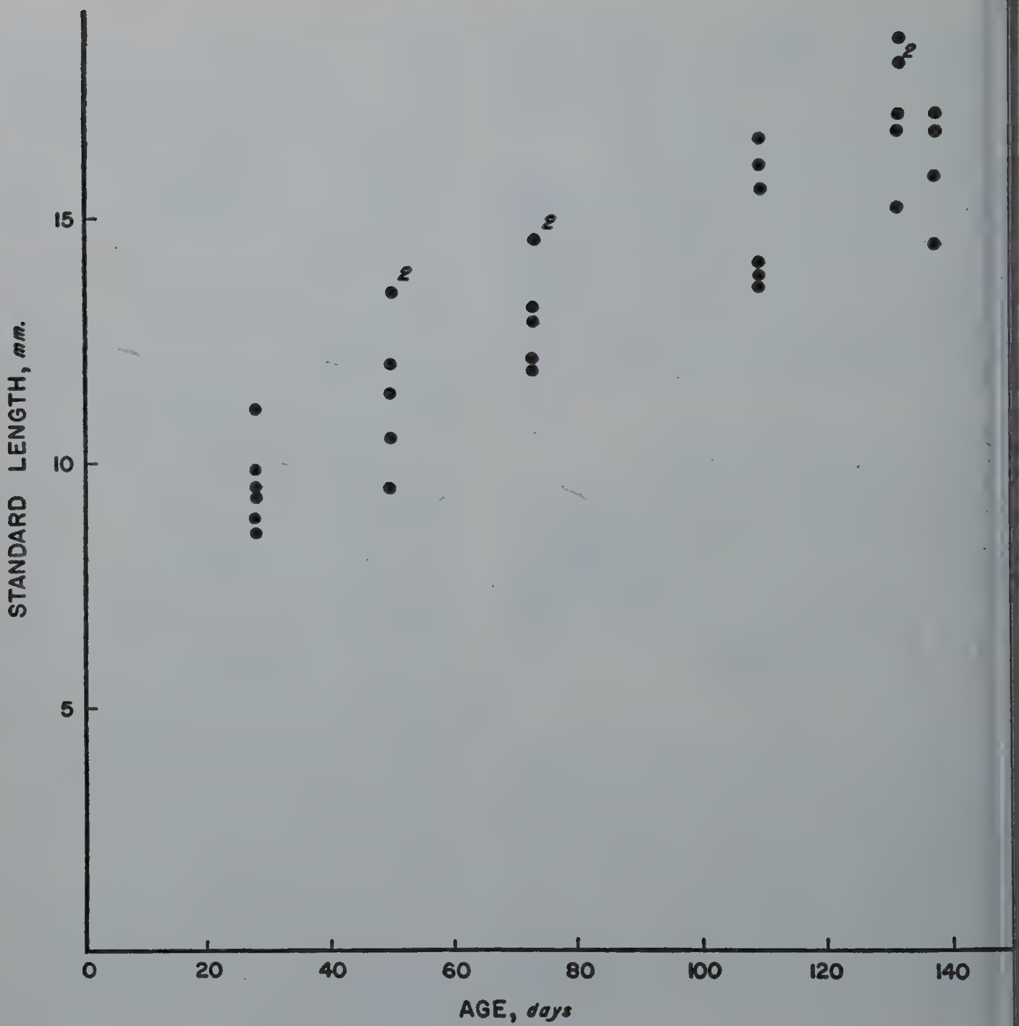
According to Witschi's theory of "cortico- medullary inductors," (1939-1942), sex dif- ferentiation in the lower vertebrates is the resultant of an antagonistic action between the female or cortical and the male or medul- lary components of the gonad. Sex is decided by one component becoming dominant over the other. This is accomplished by a process of inhibition, one component apparently sup- pressing the other through the action of specific substances, cortexin and medullarin, assumed to be produced by cortex and me- dulla respectively. Which of the opposing components dominates is determined by their relative strength or power. Cortex "weaker" than medulla points to maleness; cortex "stronger" than medulla points to femaleness.

These concepts were derived from studies of the developmental stages in gonadal dif- ferentiation in amphibia and from experi- ments with them designed to evaluate the external factors, such as temperature, hor- mones, etc., which are capable of overriding the genetic sex constitution of the individual.

The lower vertebrates represent an ex- tremely diverse group of animals and this may also be said of the teleosts alone. We doubt if the regional areas of the platyfish gonad can be compared satisfactorily on a morphological level, with those of *Rana,* for example. If the comparison is made, for whatever it is worth, the peripheral region of the platyfish gonad seems to be associated with the most important cells of the testis and the central core with components of the ovary. This is just opposite to the conditions in the frog. The effects of hormones on the teleost gonad are discussed in the accom- panying paper by Gordon & Aronowitz (1951).

SUMMARY AND CONCLUSIONS.

1. A histological examination of the gon- ads of very young members of *Platypoecilus maculatus* in two broods has revealed that



TEXT-FIG. 2. Scatter diagram of the relationship of age to standard length of the fishes of brood 263. N = 40; $r = +0.90$.

all the members are male. No ovaries or ovary-like gonads were found. This confirmed the observation that all the members of the two broods numbering 262 individuals are male, none are female.

2. The genetic mechanism for sex determination responsible for the production of the two all-male broods was known. The female platyfish had two X chromosomes (XX), and the male platyfish had two Y chromosomes (YY); all their offspring possess an identical combination of sex chromosomes, XY, which is characteristic of the male. This genetic theory was confirmed by the histological results obtained.

3. During morphogenesis of the testis the following processes were found (they are also summarized in Table 1):

a. Fusion of the two testicular primordia.
b. Increase in size of the testis.
c. Spermatogenesis.

4. Spermatophores accumulate in the sperm duct. Upon relaxation of the gen sphincter, the spermatophores pass thro the terminal opening of the sperm duct o the genital papilla to the exterior and to gonopodium.

5. As the platyfish grows older, it increa in length. At the same time, as the te matures, the anal fin is transformed i the gonopodium.

6. No difference in the rates of devel ment of the testis and gonopodium was fo in the Black-banded (*N* gene) and Spot (*Sp* gene) siblings of the platyfish.

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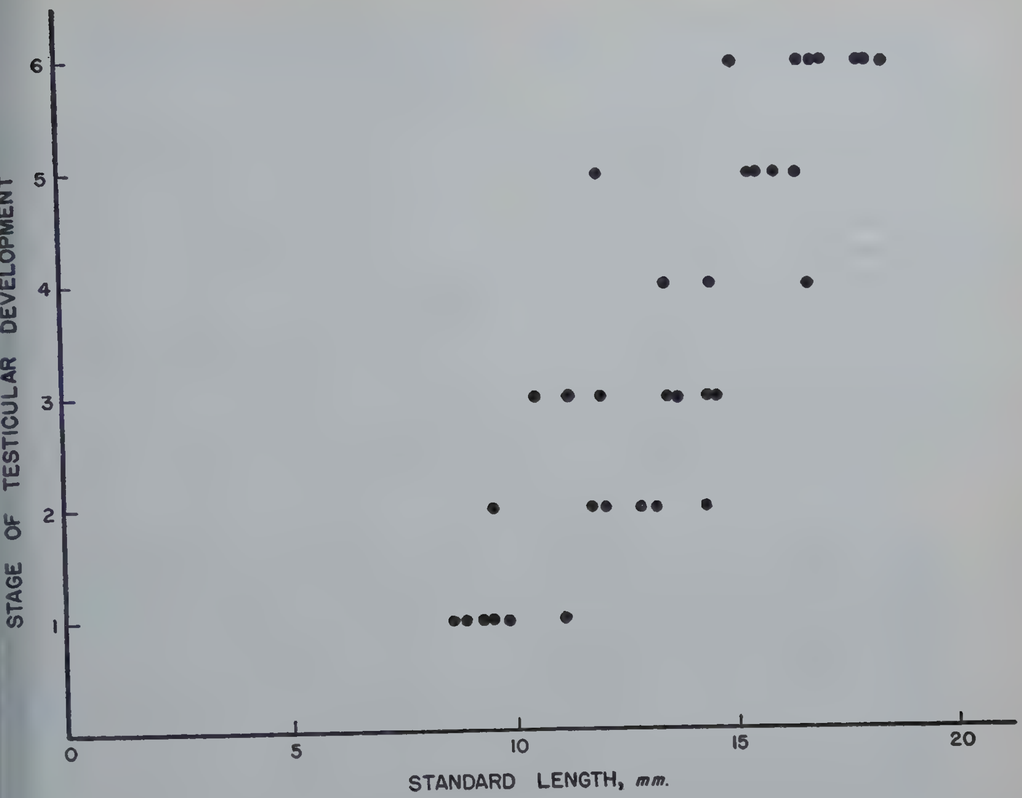

TEXT-FIG. 3. Scatter diagram of the relationship of the standard length of a fish to its stage of testicular development in the fishes of brood 263. N = 40; $r = +0.94$.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Sexually Indifferent Gonad.* The small gonad primordia contain discrete primordial germ cells randomly distributed. There is no visible cortex or medulla. Embryo 263-B. Transverse section. Iron hematoxylin. Approximately 1500×. **PGC**, primordial germ cell.

Fig. 2. *Testicular Stage One.* The paired testis is composed of germ cells which occur discretely and in small groups at the periphery of the gonad. The bulk of gonad is composed of stroma cells. Animal 260-3. Transverse section. Harris' hematoxylin. Approximately 1200×. **PGC**, primordial germ cells; **S**, stroma cell.

Fig. 3. *Testicular Stage Two.* The small spermatogonial acini are critically located. In each testis the stroma cells of the medullary region are transformed into a large central sperm duct. Animal 260-5. Transverse section. Harris' hematoxylin. Approximately 450×. **D**, sperm duct; **S**, stroma cell; **SG**, spermatogonial cell.

Fig. 4. *Testicular Stage Three.* The peripheral region is thick and forms a distinct outer zone, which at this level of development is composed mainly of large spermatogonial acini. The branched sperm ducts are the major components of the medullary region. Animal 263-5. Transverse section. Harris' hematoxylin. Approximately 400×. **M**, mesorchium; **SG**, spermatogonial cell; **T**, sperm duct tubule.

PLATE II.

Fig. 5. *Testicular Stage Four.* The cortical region is considerably thicker. Primary spermatocytes predominate. Animal 263-6. Transverse section. Heidenhain's modification of Masson's trichrome stain. Approximately 300×. **M**, mesorchium; **P**, peritoneal membrane; **PSP**, primary spermatocyte acinus; **SG**, spermatogonial cell; **T**, sperm duct tubule.

Fig. 6. *Testicular Stage Five.* The secondar spermatocyte acini appear at thi stage of testicular development; the are for the most part found near th center of the testis. For the first tim the linear arrangement of the acin which form the cords may be seen Animal 263-3. Transverse section Harris' hematoxylin. Approximatel 90×. **D**, sperm duct; **PSP**, primar spermatocyte acinus; **SSP**, secondar spermatocyte acinus.

Fig. 7. *Testicular Stage Five.* Note the growt and incomplete fusion of the paire testis. The cords of acini are pro nounced. In the medullary region sperm duct tubule opens into the lef sperm duct. Animal 260-12. Trans verse section. Harris' hematoxylin Approximately 90×. **BV**, blood vessel **CH**, cord of acini; **D**, sperm duct; **PSP** primary spermatocyte acinus; **SSP** secondary spermatocyte acinus; **T** sperm duct tubule.

PLATE III.

Fig. 8. *Testicular Stage Six.* The bipartit origin of the testis may be discerne dorsally. Spermatophores are presen both in the cortex and in the sperm duct network. The union of the paire sperm ducts to form the vas deferen may be seen. Animal 260-16. Trans verse section. Harris' hematoxylin. Ap proximately 80×. **D**, sperm duct; **SP** spermatophore; **T**, sperm duct tubule **VD**, vas deferens.

Fig. 9. *The Later Stages of Spermatogenesis* Note the indistinct cytoplasmic limit of the primary spermatocytes, the sec ondary spermatocytes and the sperma tids. The nuclei of the primary sperma tocytes are much larger than those o the secondary spermatocytes. Note the mature and immature spermatophore which are recognizable by the peri pheral aggregation of the spermatozoa Animal 263-30. Longitudinal section Heidenhain's modification of Masson's trichrome stain. Approximately 450× **PSP**, primary spermatocyte acinus; **SC** Sertoli cell; **SP**, spermatophore; **SSP** secondary spermatocyte acinus; **ST** spermatid acinus; **T**, sperm duct tubule.

g. 10. *Ciliated Cuboidal Epithelium Lining the Sperm Ducts.* Note the sperm duct fluid which stains with aniline blue. Animal 263-30. Longitudinal section. Heidenhain's modification of Masson's trichrome stain. Approximately 450×. **C**, cilia; **DE**, duct epithelium; **E**, erythrocyte; **F**, sperm duct fluid; **St**, spermatid acinus.

Plate IV.

g. 11. *Terminal Portion of the Immature Male Reproductive System.* The testis is in Stage Two. The cephalic portion of the sperm duct leading from one testis is branched. The remaining portion of the duct is unmodified. Animal 263-9. Longitudinal section. Iron hematoxylin. Approximately 120×. **BL**, urinary bladder; **D**, sperm duct; **I**, intestine; **TS**, testis; **U**, ureter. (In this Figure and in Figure 12 the anterior-posterior axis runs from left to right).

Fig. 12. *Terminal Portion of the Mature Male Reproductive System.* Note the increase in size and the modifications of the genital system, compared with Fig. 11. The testis and sperm ducts have increased in complexity. A genital sphincter is found around a portion of the sperm duct at the base of the genital papilla. The genital opening is at the apex of the genital papilla. A partition separates the genital system from the digestive system and forms a definite uro-genital sinus. Animal 263-28. Longitudinal section. Heidenhain's modification of Masson's trichrome stain. Approximately 120×. **A**, anus; **BL**, urinary bladder; **GP**, genital papilla; **GS**, genital sphincter; **P**, partition; **UGS**, uro-genital sinus; **VD**, vas deferens.

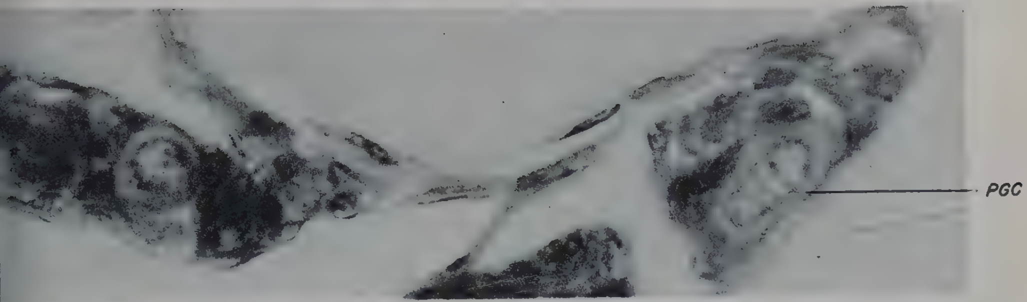

FIG. 1.

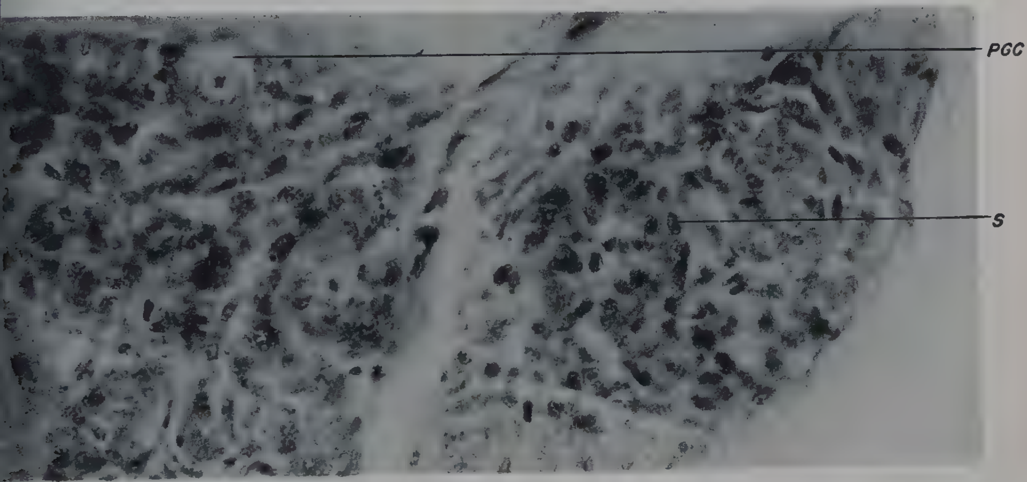

FIG. 2.

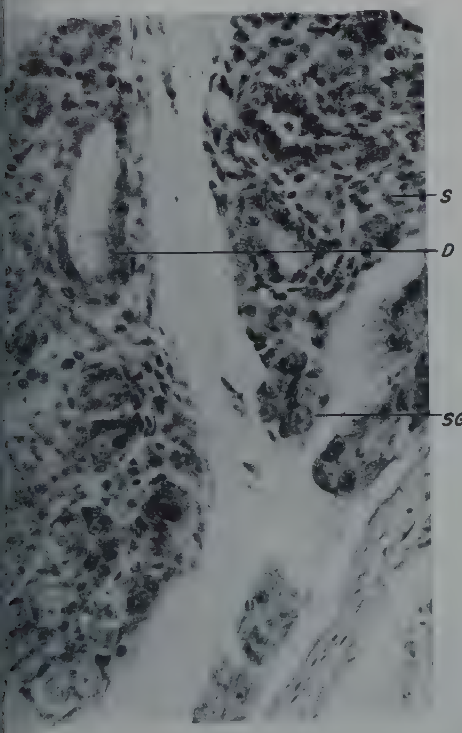

FIG. 3.

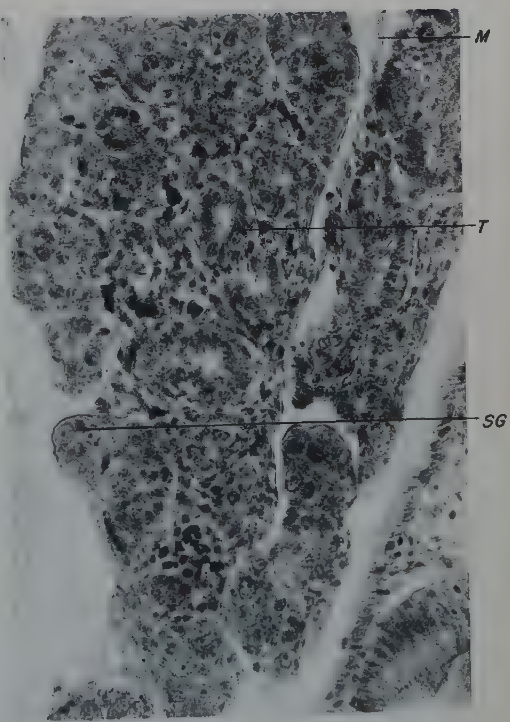

FIG. 4.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. I.

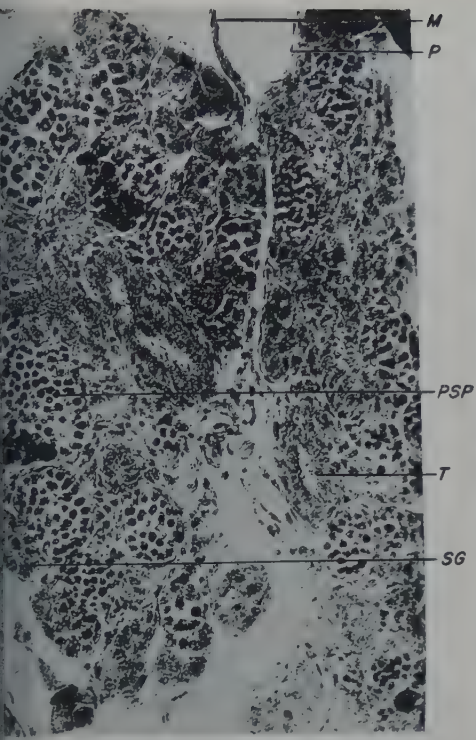

FIG. 5.

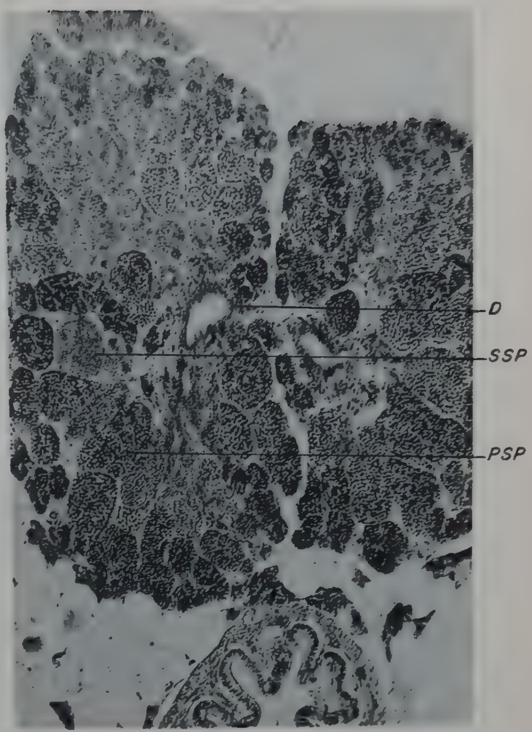

FIG. 6.

FIG. 7.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. I.

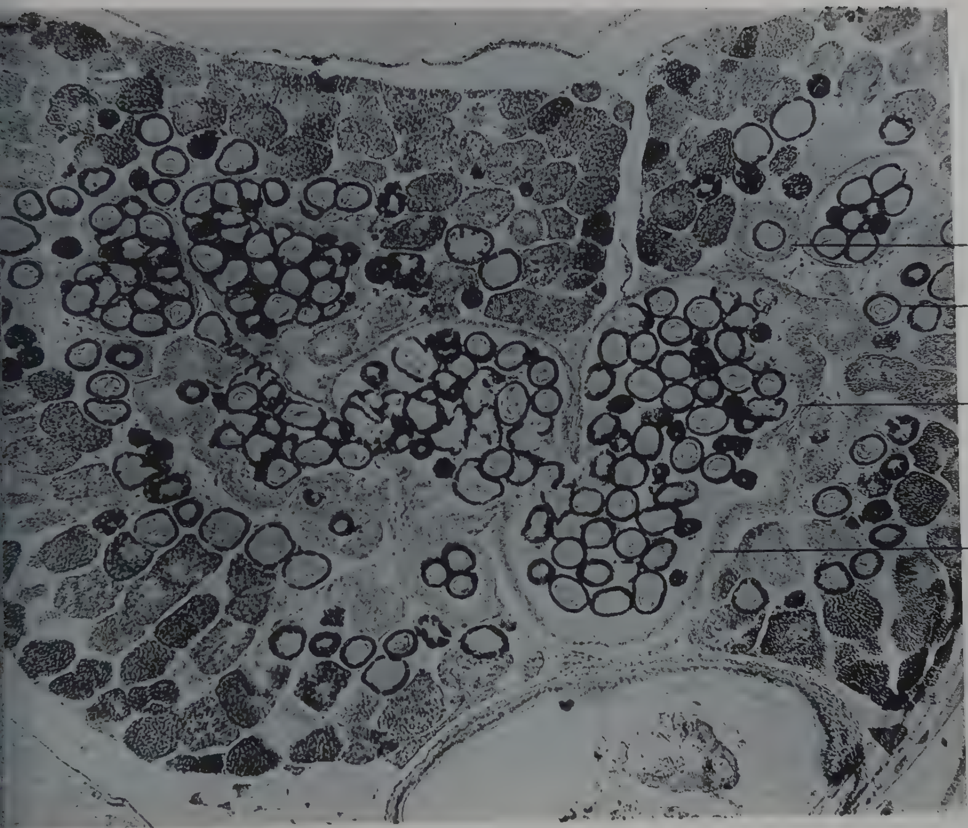

FIG. 8.

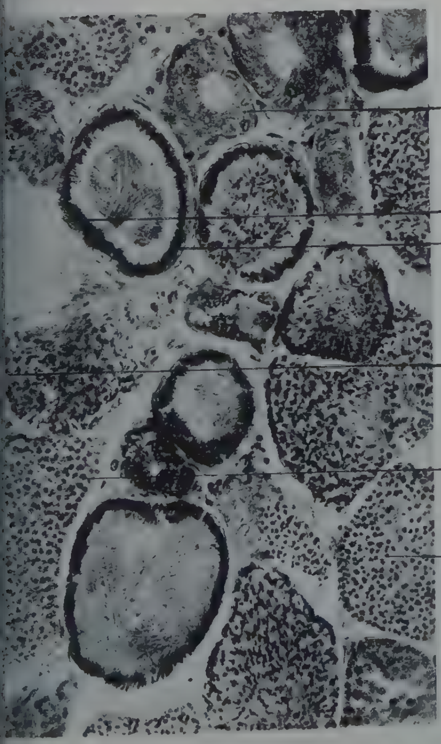

FIG. 9.

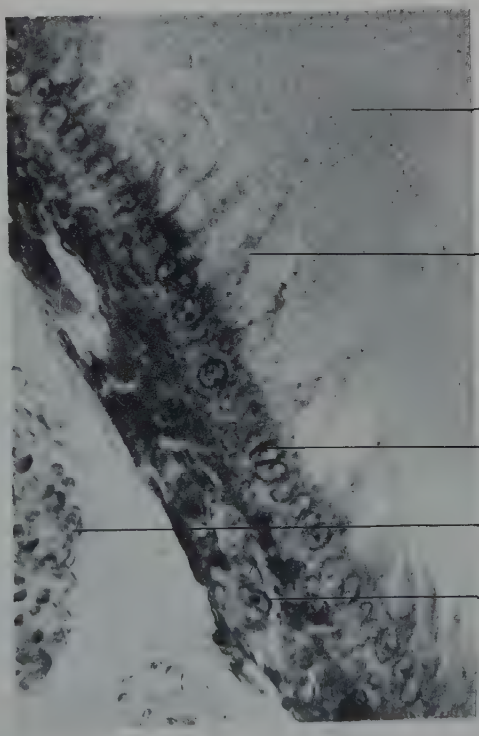

FIG. 10.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. I.

FIG. 11.

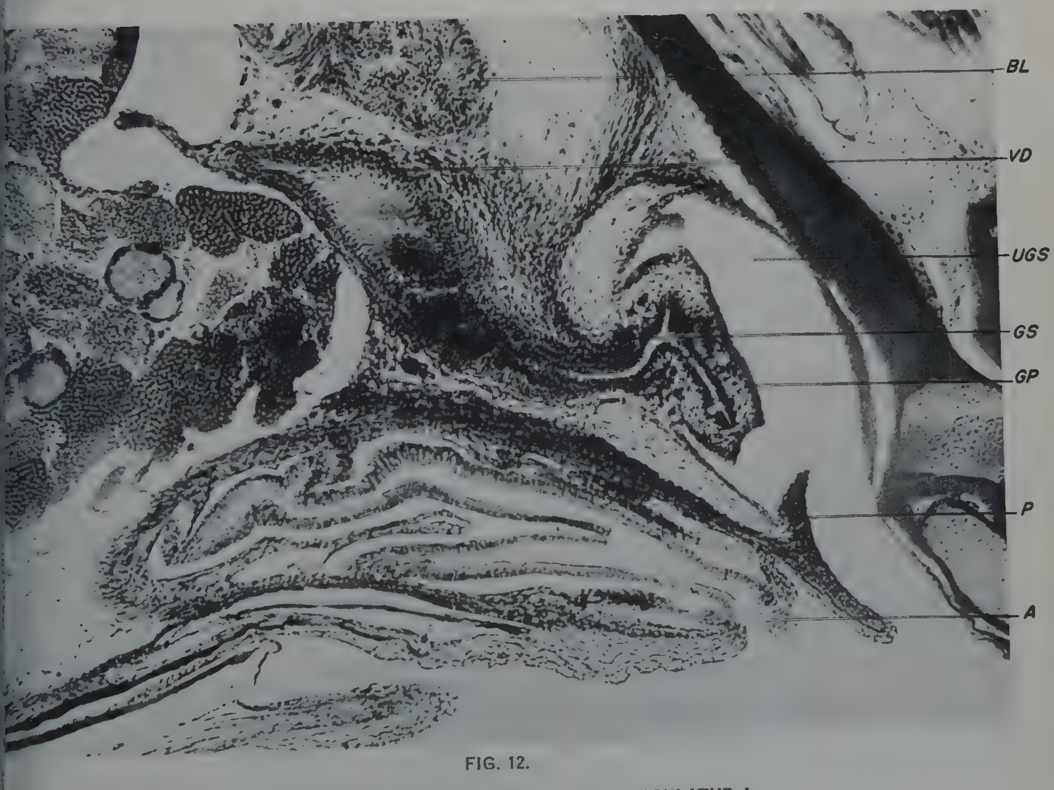

FIG. 12.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. I.

9.

Sex Determination in *Platypoecilus maculatus*. II. History of a Male Platyfish that Sired All-female Broods.

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(Plates I-IV; Text-figure 1).

The cytological and genetical aspects of sex determination have been emphasized by Bridges (1939), the physiological influences by Goldschmidt (1938), and the developmental, endocrine and environmental factors by Willier (1939), Danforth (1939) and Witschi (1939). The consensus is that the sex of most vertebrate animals is the product of the interaction of many endogenous and exogenous forces. In some animals, however, the genetic or chromosomal mechanism for sex determination has attained greater influence than the exogenous agents. For example, the genetic factors are stabilized in the teleost fishes *Platypoecilus, Lebistes* and *Oryzias,* as in *Drosophila.* Knowledge of sex-linked inheritance in these forms makes the results of genetic experiments predictable. When exceptions to expectancy appear, they tend to strengthen rather than to weaken the basic principles. For example, in the platyfish, *Platypoecilus maculatus,* Gordon (1946a) found an exceptional male which had a phenotype usually associated with that of a female. The unexpected male was tested with a normal female platyfish and proved to be a functional male. Gordon (1947) suggested that the exceptional male was a product of genetic sex reversal because it retained the chromosomal constitution of a female. This was revealed when the exceptional male and the normal female produced a series of broods which totalled 153 young. All were female.

GENETIC ANALYSIS OF THE SEX-REVERSED PLATYFISH.

The female parent of the exceptional male platyfish was heterozygous for the striped side (*Sr*) gene. Its male parent carried the spotted dorsal fin (*Sd*) gene on its Y chromosome and a spotted side (*Sp*) gene on its X. These genes are but three of a series of five dominant, sex-linked alleles for the development of macromelanophore patterns, which are described in detail by Gordon (1948).

The genetic data were represented by Gordon (1947) essentially as follows:

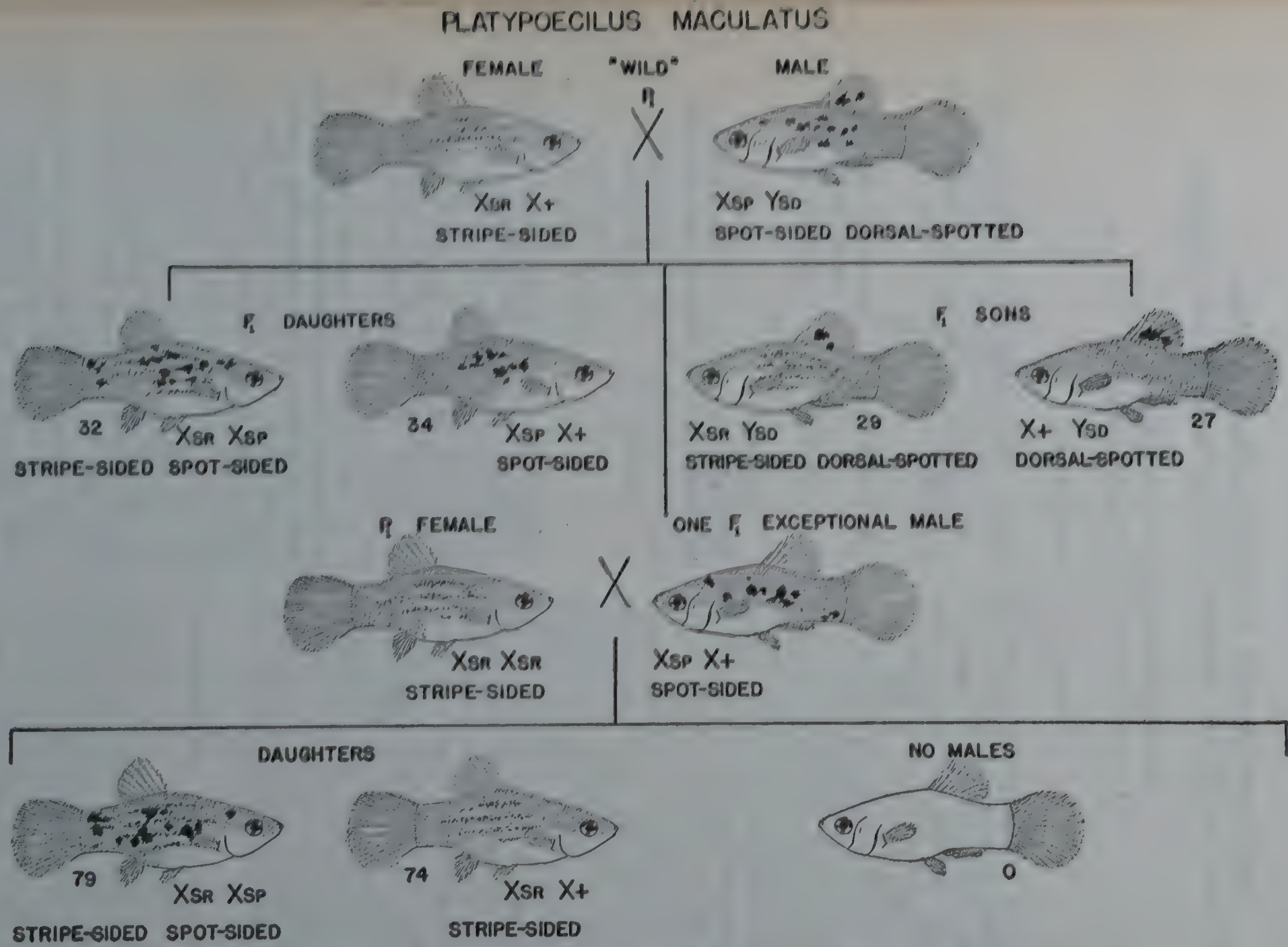
	P_1
Striped Female	Spot-sided, Spotted dorsal fin Male
(X) *Sr*/(X) +	(X) *Sp*/(Y) *Sd*
	F_1
Daughters	Sons
32 (X) *Sr*/(X) *Sp*, striped and spotted	29 (X) *Sr*/(Y) *Sd*, striped, spotted dorsal
34 (X) *Sp*/(X) +, spotted	27 (X) +/(Y) *Sd*, spotted dorsal
	1 (X) *Sp*/(X) +, spotted, *exceptional type*

All but one of the 35 spot-sided animals, (X) *Sp*/(X) +, were females. The one spotted son was either the product of a crossing-over of the sex chromosomes in its male parent (X) *Sp*/(Y) *Sd,* which produced a (Y) *Sp* gamete and an (X) +/(Y) *Sp* individual, or it was the result of sex reversal of an (X) +/(X) *Sp* female.

To test which of these two possibilities was correct, the exceptional spotted male was mated to a homozygous stripe-sided female, (X) *Sr*/(X) *Sr* (Pl. I, Fig. 1). If the abnormal male resulted from a cross-over, and was (X) +/(Y) *Sp,* 50% of his offspring would be female and 50% would be male, and all the males would be spotted. If he had the genetic constitution of a female, (X) *Sp*/(X) +, all of his offspring would be female, and one-half of the females would be spotted.

The exceptional spotted male, mated with a normal, homozygous striped female, produced 153 offspring, all of which were female; 79 were spotted and striped and 74 were merely striped (Pl. I, Fig. 2). These data suggest that the exceptional spotted male was the product of sex reversal and that it had retained the unaltered chromosomal constitution of a female. This may be expressed genetically as follows (Text-fig. 1):

[1] From the Genetics Laboratory of the New York Zoological Society at the American Museum of Natural History, New York 24, N. Y. The animals used in this study were obtained from work being done under a grant to the New York Zoological Society from the National Cancer Institute, National Institutes of Health of the U. S. Public Health Service for the project: Genetic and correlated studies of normal and atypical pigment cell growth. The authors wish to thank James W. Atz and Donn Eric Rosen for reading the manuscript.



TEXT-FIG. 1. The mating which led to the discovery of the functional male having the genetic constitution of a female. A striped-sided female, XX, (63-1), was mated to a spot-sided, spotted dorsal male, XY, (62-11), both of which were of the Rio Jamapa, Mexican stock. In their F_1 population only spot-sided females were expected, but a single male of this phenotype appeared. When the exceptional spot-sided male was tested by mating it to a homozygous stripe-sided female, XX, the parents produced 153 daughters

	P_1
Female	Male (exceptional)
(X)*Sr*/(X)*Sr*	(X)*Sp*/(X)+
	F_1
Females	Males
79 (X)*Sr*/(X)*Sp*	None
74 (X)*Sr*/(X)+	None

The spotted male sired the total of 153 daughters in three separate broods which were born at monthly intervals. The three broods could have been produced by a single insemination because platyfish females have the means for storing viable sperm within the folds of their oviducts for four to five consecutive broods. Although the male was in the company of the female constantly for five months, and for two months after the last brood, no more than three broods were produced.

The same female, (X)*Sr*/(X)*Sr*, was subsequently isolated for two additional months during which period she did not produce any young. She was then mated to a second, but unspotted, male, (X)+/(Y)+, and from this second mating she produced stripe-sided male and female offspring.

It was concluded, therefore, (1), that the test female was not sterile and that its sex-determining mechanism was (X)*Sr*/(X)*Sr*, and (2), that the exceptional spotted male, (X)*Sp*/(X)+, was essentially responsible for the unusual production of the all-female brood of the 153 offspring.

Histology of the Gonad in the Sex-reversed Male.

The sex-reversed male, after it appeared to be sterile, was fixed in Bouin's fluid. Its testis was dissected, sectioned, stained and examined histologically. For comparative study, testes were also examined from young adult fertile males and from older senile males that had previously sired many broods but had passed their active reproductive period.

The histological picture of the testis in the normal platyfish reveals that it is a single, fused, acinar gland in which the spermatogonial elements are organized into globular units rather than into seminiferous tubules (Pl. II, Fig. 3). The primary spermatogonia are at the periphery of the gland, and from the periphery to the center there are closely packed acini containing primary spermatocytes, secondary spermatocytes, spermatids and spermatophores. The spermatophores are spherical masses of mature spermatozoa the heads of which lie at the periphery, embedded in Sertoli cells, and the tails in the center of the sphere. (During copulation, the spermatophores are transferred by means of the male's modified anal fin or gonopodium to the urogenital orifice of the female. Within the female, the spermatophores break up and the spermatozoa are free).

The center of the testis has two main branching sperm ducts which are usually filled with spermatophores. When the ducts are filled with spermatophores their walls are somewhat distended, and at this time their epithelial cells are cuboidal; at other times they are columnar. Some interstitial tissue is found around the ducts and a bit of it between the acini. The ducts contain a small trace of nongranular "colloidal" material which takes a faint acidophilic stain. The composition and function of the colloid are unknown.

The testes from two old swordtail males that had been fertile but were no longer capable of inseminating females were studied for comparative purposes. The swordtails were used because they were available. The histological structures of the testes of adult platyfish and swordtails are practically identical.

The testis of one old swordtail has definite signs of disorganization and disintegration (Pl. II, Fig. 4). The spermatogonial elements are scattered irregularly throughout the gland. The non-glandular, connective, interstitial tissue, containing many degenerating sperm, is abundant. The ducts contain spermatophores, many of which are in the process of disintegration. The ducts contain much colloid.

Another testis taken from an old swordtail was studied. The male had been kept with a female for many months, during which time no young were produced. When, however, the female was autopsied she was gravid. The gonad of the second male had similar abnormalities to the first, but the irregularities were not so pronounced.

A cross-section of the testis of the sex-reversed platyfish reveals a highly abnormal gland (Pl. III, Fig. 6; Pl. IV, Fig. 7). The most noticeable defect is the great enlargement of the sperm ducts, the walls of which are composed of squamous cells. The distended ducts, which occupy most of the testis, contain much colloid, spermatophores in the process of disintegration, free spermatozoa and a few normal spermatophores. The gland is almost devoid of sex cells in their early stages of spermatogenesis.

At the periphery of the testis there are a few nests of primary germ cells. Toward the center between the branches of the sperm ducts there are large masses of degenerating primary germ cells. Plate IV, Fig. 8, shows a series of germ cells; those at the far right are normal, and those at the far left, in the process of disintegration. In this connection, Wolf (1931) describes degenerating germ cells in all stages in the development of the testis except the last, in the mature gland.

The interstitial tissue in the testis of the sex-reversed platyfish seems normal. No degenerate sperm are found outside of the sperm ducts. The organization of the gland is unusual in that there are relatively few early spermatogonial elements, but those that are present are in their normal position. These anomalies are not comparable to those of the testes of the aged swordtail males.

The gonopodium of the sex-reversed male platyfish was normal.

Discussion.

Sex reversal in a male platyfish was reported by Breider (1942) prior to the one Gordon (1947) discovered, but Breider did not describe the histology of the exceptional male's gonad. Tavolga (1949), in the course of an endocrinological analysis, found a young platyfish that had the phenotypic, sex-linked color pattern of a female but a typical juvenile male gonad, but this was not analyzed genetically.

The sex-reversed male platyfish described in this paper is of particular interest because its origin and genetic history are known. After the platyfish was fixed for histological analysis its gonopodium was examined and found to be normal; this showed that its incapacity to continue to function as a fertile male could not be attributed to a disfunction in this important secondary sex character.

The sex-reversed male platyfish had inseminated a female successfully. It therefore had a normal, or at least a functional, gonad for a time. The eventual disfunction of the testis was not due to the premature senility of the male because histologically its gonad was totally different from the involuted gonads characteristic of senescent males. The sex-reversed male was only 14 months old and therefore was not senile at the time it was fixed.

The gonad of the sex-reversed male may have become abnormal owing to an upset in the hormonal balance in the organism as a whole. All the histological abnormalities reported in the sex-reversed platyfish are found in studies of testes of *Lebistes* which are experimentally treated with hormones. For example, in one of his figures Berkowitz (1941) illustrated the presence of free spermatozoa in the sperm ducts of sterile guppy males that had previously received injections of estrogens. Furthermore, Eversole (1941) reported a scarcity of early spermatogonial stages in the testes of guppies that had been treated with pregneninolone, a hormone that has a powerful androgenic effect in fishes.

Aronowitz & Gordon (Ms.) also detected spermatophore disintegration and a scarcity of early spermatogonial stages in hybrids between the platyfish (*P. maculatus*) and swordtail (*X. hellerii*) (Pl. III, Fig. 5). Gordon & Rosen (1951) suggested that the abnormal, nonfunctional testes in some hybrids may have been produced by the endocrine imbalance initiated by the union of dissimilar sex chromosomes. Friess (1933) found free sperm in the sperm ducts of some sex-reversed swordtail males. She suggested that this was indicative of sex-reversed fishes. In the sex-reversed platyfish male we found no evidence, at the time it was examined, of any ovarian elements, but the XX platyfish may have had an incipient ovary quite early in life.

Cohen (1946), after subjecting male platyfish at two weeks of age to the effects of alpha-estradiol benzoate for twenty weeks, found that their testes were small, bipartite and compact. The sperm duct epithelium was columnar, the interstitial tissue was profuse, no ova were present, spermatophores and spermatids were few. Equally young males treated for shorter periods, for eight to twelve weeks, showed ova in ova-testes, but males treated for twenty weeks showed a falling off of the inhibiting effects of the estrogen. Cohen also studied the effect of pregneninolone on young, genetically determined female platyfish. The ovaries of treated fish were much smaller than those of their controls; mature ova with their usual complement of yolk were entirely wanting. Tavolga (1949) repeated some of this work and obtained similar results.

From the data presented, an interpretation of the process of sex reversal in the exceptional (X) *Sp*/(X) + male may be outlined. Some hormonal imbalance (induced probably by a fortuitous combination of genes for sex determination carried on both sex and autosomal chromosomes) transformed a potential female platyfish to a functional male. To use Danforth's terms, its genetic sex was female, its real sex was male.

In the process of sex reversal, which is interpreted as having been aberrant from start to finish, a stage was reached in which the exceptional, genetically XX platyfish with all the organs of a normal, functional male was capable of copulation and successful insemination. The duration of this stage of sexual normality and fertility was brief. The hormonal imbalance inherent in the XX male continued, and eventually caused the testis to become abnormal. Subsequently, the testis was incapable of providing functional spermatozoa. As a consequence the male was, in effect, sterile. Its sexual incapacity was reached far in advance of the ordinary period of senescence.

Investigators studying embryonic differentiation and development in vertebrate animals have been impressed with the striking effects of sex hormones on fishes. Witschi (1942) attributes this in part to the peculiarities of their genetical constitution, saying that the lower vertebrates have no completely developed genetical mechanism of sex determination. Consequently, he says, they are, at least during early development stages, in a relatively labile condition and secondary influences can comparatively easily shift sex determination in one direction or the other. He adds that the situation is complicated by the fact that embryologically as well as genetically the species studied are not completely enough analyzed.

The general opinion that fishes have a labile mechanism for sex determination has been derived, in some measure, from study of the swordtail, *Xiphophorus hellerii*. It arose from the widely cited early work of Essenberg (1926), who showed that functional sex reversal occurs spontaneously in

this species. It is a rare phenomenon. It may have been forgotten that Essenberg had only two swordtails which had first been functional females and which later became functional males. Several workers after Essenberg showed that some swordtails are protogynous. Some of the young pass through a female-like stage of gonadal development before becoming functional males. After Essenberg, no new instances of complete and functional sex reversal in this species have been reported. From the numerous citations referring to the original sex-reversed swordtail one gets the erroneous impression that the phenomenon is common.

On the genetic level, the swordtail is a puzzling species with reference to its mechanism for sex determination. Suggestions made to explain the mechanism are contradictory. In the main this is because no sex-linked genes have, as yet, been discovered in this species. In this connection, Witschi (1939), basing a statement on Breider (1936), said that the heterochromosome of *Platypoecilus maculatus* is homologous with one in the closely related *Xiphophorus hellerii*. Breider's evidence is somewhat ambiguous. Breider thought that the gene *Mo*, for montezuma pattern, was an attribute of the swordtail. He then pointed out that *Mo* was one of a series of sex-linked alleles which also contained a number of platyfish genes, *N*, *Sp*, etc. Gordon (1946b, 1948) showed that the so-called *Mo* gene of the swordtail is actually a combination of two platyfish genes, *Sr* and *Dr*. These platyfish genes, according to Gordon's interpretation, had been incorporated into swordtail germ plasm through a process of introgressive hybridization. The transfer of genes was accomplished by fish fanciers' breeding methods under conditions of domestication.

The term heterochromosome with reference to the sex chromosomes of *Platypoecilus maculatus* is unsatisfactory because the platyfish has a duality of sex-determining mechanisms. In natural populations of this species from three geographically isolated rivers in Mexico, the genetic mechanism for sex determination is XX for females and XY for males. In a natural population from the Belize River in British Honduras, and in domesticated stocks, such as Breider and other geneticists had previously studied (see Gordon, 1947), the genetic mechanism for sex determination is WY (or WZ) for females and YY (or ZZ) for males. By "tagging" the platyfish sex chromosomes with sex-linked genes, and then hybridizing them with the swordtail, some information was obtained on the compatibility of each kind of platyfish sex chromosome with the pairing member chromosome from the swordtail in the platyfish-swordtail hybrids. Some of the interesting results obtained were described by Gordon (1948) and their importance as isolating mechanisms are outlined by Gordon & Rosen (1951).

No generalized statement on the strength or weakness of the genetic mechanisms for sex determination in fishes is satisfactory at this time. In *Platypoecilus maculatus* and in *P. variatus* and *P. xiphidium*, as well as in *Lebistes* and in *Oryzias*, they are definitely stable despite some exceptions. In other species of teleosts which have been studied, for example in *Xiphophorus hellerii*, and in *X. montezumae*, as well as in two of the three species of *Limia*, and in *Macropodus*, *Carpio* and *Carassius*, the mechanism is unknown.

Summary.

1. The origin and genetic background of a platyfish, *Platypoecilus maculatus*, with the genetic sex chromosome mechanism of a female and the morphology and physiology of a male, is described. It was found in a stock in which the males are heterogametic (XY) and the females homogametic (XX). When the exceptional XX male was mated to a normal XX female, 153 offspring were produced, all of which were XX females.

2. The XX sex-reversed male was fertile for a brief period only. When it was sterile it was fixed and sectioned. A histological examination of its testis revealed hypertrophied sperm ducts, spermatozoa-free outside of spermatophores, early spermatogonial stages scarce and masses of degenerating primary germ cells. These features denote sterility. Similar histological conditions have been reported in the testes of related fishes after treatment with sex hormones. It has been suggested that the premature sterility in the sex-reversed male was due to a hormonal imbalance, brought about by androgenic agents acting upon a genetically constituted female.

Postscript.

While the present paper was in press a paper by Albert W. Bellamy and Marion L. Queal, entitled "Heterosomal inheritance and sex determination in *Platypoecilus maculatus*," was published in *Genetics*, 36(1): 93-107, 1951. The authors described a series of matings of domesticated (YY-YW) platyfish which produced 10,686 offspring; 5,324 of them were male, 24 of which were exceptional with reference to their phenotypes. Most of the exceptional males were tested in another series of matings. Seven of them apparently were genetic sex-reversals.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. The male with the genetic constitution of a female *Platypoecilus maculatus* (Pedigree 159-21) is shown at the lower left. It carries the sex-linked gene *Sp* for macromelanophores on the sides and the autosomal gene, *Co*, for comet, a faint line along the upper and lower margin of the tail. The standard platyfish female is at the right. It carries the sex-linked gene *Sr*, for striped sides and two autosomal genes, *Cc*, for complete-crescent, and *O*, for one-spot. Note the dimorphism in total size, shape, and specifically in the structure of the anal fin. This pair produced 153 offspring all of which were female. See figure 2.

Fig. 2. The females produced by the pair shown in Fig. 1 were of two types with reference to macromelanophore genes. About half of them were spot-sided, gene *Sp*; one is shown at the bottom of the figure. The other half were recessive for this gene, +; one is shown at the top. Note that the tail patterns are the recombination products of the parental types. The non-spot-sided female, the upper, has the *OCo* genes for one-spot and comet while the spot-sided one, the lower, has *Cc*, the gene for complete-crescent. Every female tested proved to be fertile (Pedigree 167).

(Photographs of Figures 1 and 2 made by S. C. Dunton, Staff Photographer, New York Zoological Society).

PLATE II.

Fig. 3. Longitudinal section of the testis of a young, normal, sexually mature platyfish male, cut at 7 micra and stained with hematoxylin and eosin. Magnification approx. 100×. The arrangement of the spermatogonial elements is characteristic; the acini which contain the early stages of spermatogenesis are near the periphery of the gland, and the acini which contain the later stages of spermatogenesis are near the center. The sperm duct is filled with closely packed spermatophores. **D**, sperm duct; **SC**, spermatocyte acinus; **SP**, spermatophore acinus; **ST**, spermatid acinus.

Fig. 4. Cross-section of a testis of a senescent swordtail male, cut at 7 micra and stained with Masson's trichrome stain. Magnification approx. 100×. The arrangement of the spermatogonial elements is not orderly. The number of acini is small. Large amounts of stromal tissue are present. Degenerating sperms are found both within and outside of the sperm ducts. **D**, sperm duct; **DS**, degenerating sperms; **S**, stroma.

PLATE III.

Fig. 5. Cross-section of the testis of a platyfish-swordtail hybrid, cut at 7 micra and stained with hematoxylin and eosin. Magnification approx. 100×. The sperm ducts fill most of the testis and contain free sperm. This gland resembles that of the sex-reversed male. **D**, sperm duct; **FS**, free sperm.

Fig. 6. Cross-section of the testis of the sex-reversed male, cut at 7 micra and stained with Masson's trichrome stain. Magnification approx. 130×. The sperm ducts occupy most of the testis and they contain many free sperm. The number of germ cell acini is small. **DGC**, group of degenerating germ cells; **FS**, free sperm.

PLATE IV.

Fig. 7. Free sperms in the sperm duct of the sex-reversed male, cut at 7 micra and stained with Masson's trichrome stain. Magnification approx. 1,800×. One spermatophore is in a stage of degeneration. A number of free sperm are suspended in colloid. **FS**, free sperm; **SP**, spermatophore.

Fig. 8. Primary germ cells in the testis of the sex-reversed male, cut at 7 micra and stained with Masson's trichrome stain. Magnification approx. 1,000×. Those at the right are normal and take acid fuchsin, those at the left are degenerate and take aniline blue. **DGC**, degenerating primary germ cell; **PGC**, normal primary germ cell.

FIG. 1.

FIG. 2.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. II.

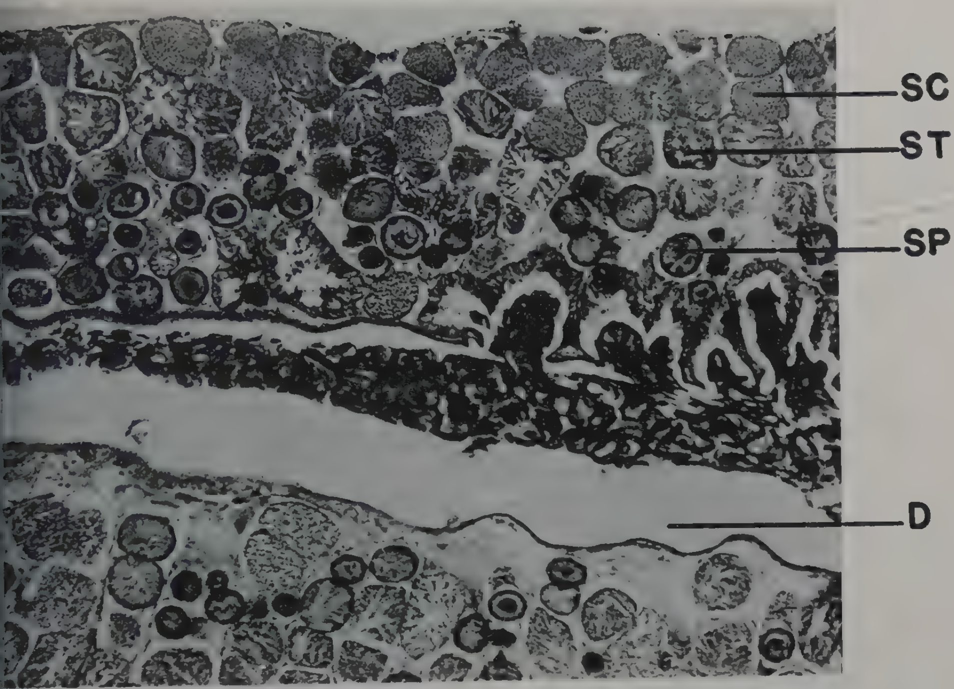

FIG. 3.

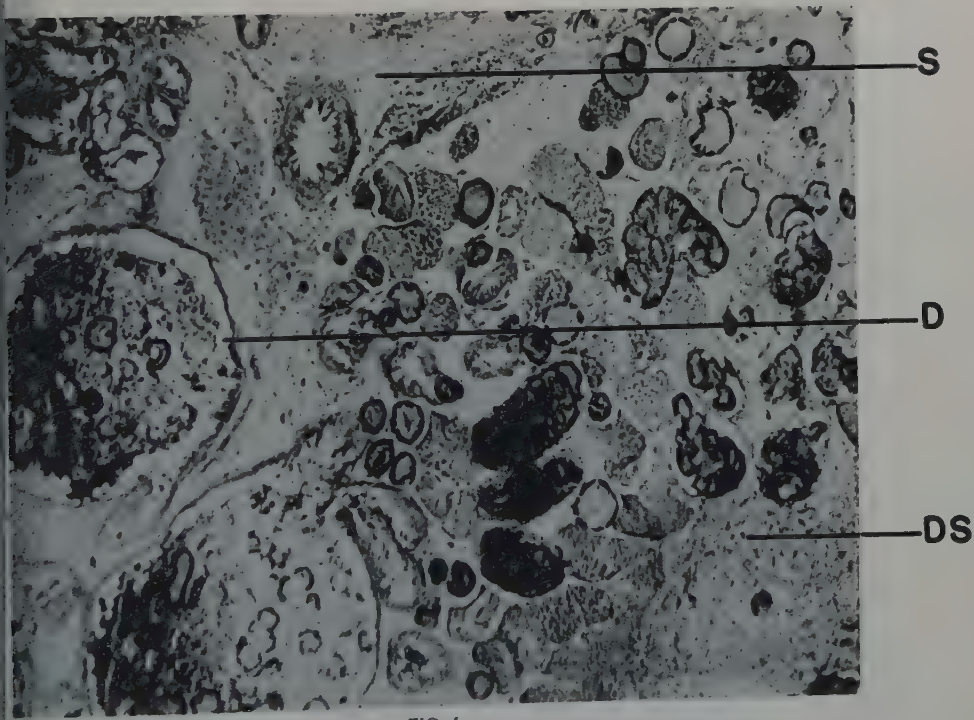

FIG. 4.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. II.

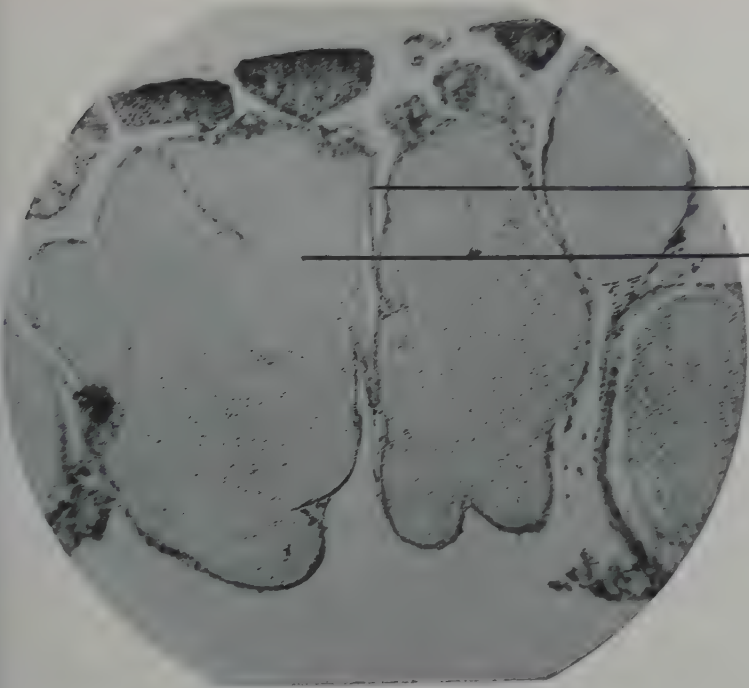

FIG. 5.

FIG. 6.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. II.

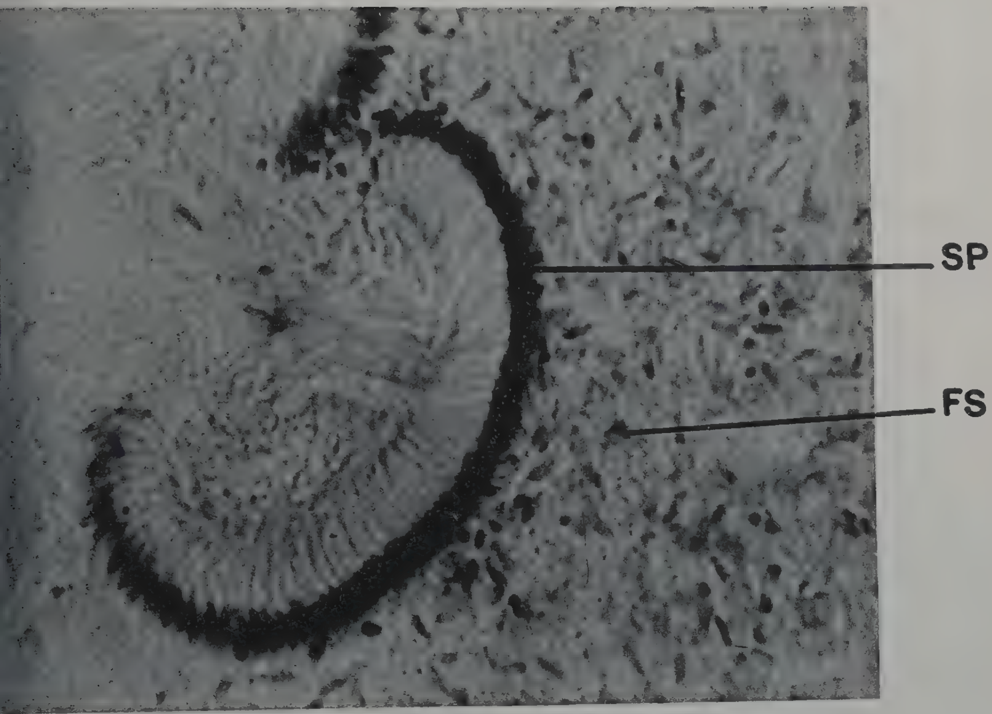

FIG. 7.

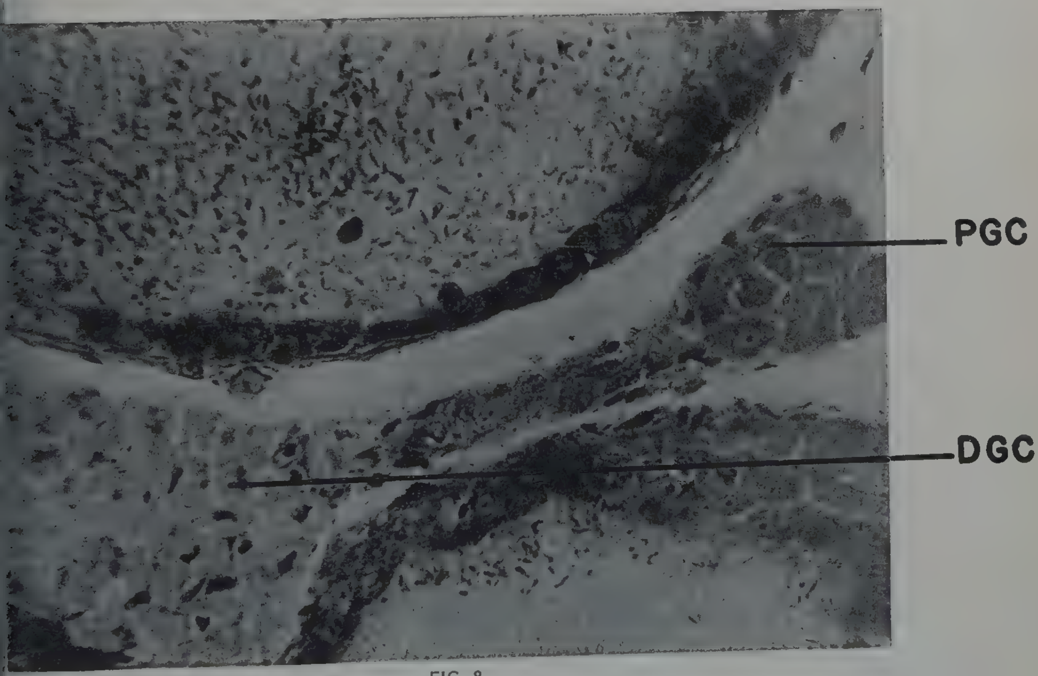

FIG. 8.

SEX DETERMINATION IN PLATYPOECILUS MACULATUS. II.

10.

Notes on Some New York Oribatid Mites.

HOWARD GEORGE SENGBUSCH.
New York University.

(Text-figures 1-16).

These notes on the New York Oribatei Acarina) were compiled as a result of a ounting demand for wider knowledge of ese relatively little-known animals. Much npetus was given to the investigation of is particular group of mites by the disovery of Stunkard (1937) that oribatid ites are the intermediate host of the anolocephaline cestodes. Oribatid mites from he metropolitan New York area were colected and examined. This article presents a st of the mites collected, including original rawings of eight species which have been itherto poorly figured, with notes on ecology, ethods of collection and mounting.

In view of the meagre descriptions and adequate figures in the literature today, uch information should prove of value to uture workers in this field. Although A. P. acot (1929, 1932, 1934, 1935, 1937) has adnirably described and figured the galumnid nd phthiracarinid mites of the northeastern Jnited States, the remainder of the oribatids rom this area have not been studied since he early papers of Nathan Banks (1895, 906, 1907, 1915) and H. E. Ewing (1907, 909). There have been isolated instances of xcellent descriptions of oribatids from the astern United States, but in most cases, uch as Kates & Runkel (1948), these papers ave mentioned only a few species. No one n this country has made any compilation of his interesting group of mites such as A. D. Michael (1884, 1888) did for the British Oribatidae and C. Willman (1931) did for he German "Moosmilben." This study, then, an be an introduction to a more complete ccount of the American Oribatei, which the writer hopes to prepare in the future.

The writer gratefully acknowledges the assistance of Dr. H. W. Stunkard, of the Biology Department of New York University, who not only encouraged him in the preparation of this report, but materially aided in the writing of this manuscript, and Dr. E. W. Baker, of the U. S. Bureau of Entomology and Plant Quarantine, for his invaluable aid in the identification of the oribatid mites. Gratitude is also extended to E. I. duPont de Nemours & Co. for their generosity in forwarding samples of various grades of Elvanol for experimentation with polyvinyl alcohol (PVA) for mounting media.

ECOLOGY.

According to Willman (1931), oribatids live in moss, in the humus of the forest floor, in lichens growing over tree stumps and trees, free on twigs and leaves, in decaying wood and in the sphagum of marshes, a few being slightly aquatic and still fewer known to inhabit the sea. They are found everywhere where plants decay with sufficient moisture and are penetrated by mycelia.

Material was collected from the following localities: (a), wooded, mossy area in Van Cortlandt Park; (b), University Heights campus, New York University; (c), wooded, dry area near Yonkers, New York; (d), mossy, damp slope behind the Reptile House, Bronx Zoo. Subsequently the following list of environments and their oribatid fauna was prepared:

VERY WET MOSS
Trimalaconothrus angulatus
Carabodes areolatus
Melanozetes meridianus
Galumna emarginatum
Pseudotritia ardua
Hoploderma magnum

HUMUS
Platyliodes scaliger
Oribatula minuta
Zygoribatula clavata
Scheloribates laevigatus

DRIER MOSS
Hypochthonius rufulus
Platyliodes scaliger
Oppia nitens
Oppia splendens
Scheloribates latipes
Scheloribates laevigatus
Galumna emarginatum
Notaspis punctatus
Pseudotritia ardua

FALLEN LEAVES
Hypochthonius rufulus
Nothrus rugulosus
Oppia neerlandica
Oribatula minuta
Zygoribatula clavata
Scheloribates latipes
Notaspis punctatus

MOSS ON TREES
Tectocepheus velatus
Carabodes areolatus
Protokalumma depressum
Pseudotritia ardua
Nothrus rugulosus (also under bark)

SPHAGNUM
Hypochthonius rufulus
Trhypochthonius badius
Pseudotritia ardua

COLLECTING METHODS.

The above list reveals that the greatest number of different species of oribatid mites were collected from moss. Various authors (Willman, 1931; Jacot, 1936, 1940; Krull, 1939; Soldatova, 1945; Pearse, 1946; Kates

& Runkel, 1948) report that the humus layer of the soil where the organic content is very high provides the optimum conditions for their recovery.

There are three methods available to obtain a high percentage of the organisms inhabiting this humus layer: the washing-screening-flotation method of Krull (1939); the modified Berlese funnel method described by Trägårdh (1933), Jacot (1936), Potemkina (1941) and Starling (1944); the modified Tullgren apparatus as described by Willman (1931).

The method of Krull was discarded on the basis of the results of Kates & Runkel (1948), who stated that the drying-cone methods (Berlese and Tullgren apparatus) "require much less time and labor to recover mites from equivalent quantities of turf and caused less injury to the mites."

The mode of action of the last two methods is essentially the same; the negatively phototropic and moisture-loving animals are driven by gradual drying to abandon their environment and fall through a funnel into a collecting vessel placed underneath. In the Berlese apparatus the funnel is surrounded by a mantle filled with water. The water is heated by a Bunsen burner, and from the inside of the funnel there results a rising warm air stream which dries out the moss from underneath. The Tullgren apparatus seems to be more practical and is the type employed in this investigation. The cone used had a top diameter of 18 inches. A 200-watt electric light, suspended about 3 inches over the material in the cone, provided the heat for the gradual drying of the material and light for the downward migration of the mites. A 20-mesh screen, placed on flanges 4 inches from the open top of the funnel, was overlaid with a triple layer of gauze, and the collected sample of moss, leaves, etc., placed on this gauze. This screen is removable to provide easy access in cleaning the apparatus. The sample was then spread out so that it was not more than 1 inch in thickness. By this procedure, in 24-36 hours one can reckon with certainty that (apart from the microfauna) all the animals have left the collected material. The half-pint fruit jar, the lid of which was pierced by and soldered to the open cone vent, is then unscrewed, and in the inch or so of water provided within to keep the animals living, will be found a variegated throng of mites, insects, worms, and whatever else had found its way into the examined material.

This apparatus corresponds quite closely to that described by Kates & Runkel (1948) as a modified Berlese funnel. From the descriptions in the literature it would seem to be more correctly labelled a modified Tullgren apparatus.

The contents of the jar were then poured into a porcelain disk filter in which 1 or 2 filter papers had previously been placed. After filtration, the filter paper was laid on a glass plate and put under a dissecting microscope. The oribatids were then removed by means of a small camel's hair brush, and placed in small containers for future study.

Permanent Mounting for Study and Identification.

Many slides were made following the method described by Kates & Runkel (1948). They first killed the mites in 70% alcohol and then mounted them directly on a glass slide in a polyvinyl-alcohol (PVA)-lactic acid medium (Downs, 1943). Living mites were mounted in the same manner without the preliminary treatment with alcohol.

While this method is quick and satisfactory for the very small and the immature specimens, the use of various PVA media for mounting and clearing the larger oribatids, especially the galumnids, proved entirely unsatisfactory. These PVA preparations shrank a great deal, crushing and distorting the mites.

Dr. Edward W. Baker recommended the following modified Berlese medium:

distilled water	50 g.
gum arabic	30 g.
chloral hydrate	200 g.
glycerine	20 g.

This also is water soluble, and mites can be mounted directly as in the case of the PVA. Mounts of this kind are alleged to have held up for twenty years or more. This medium can be used not only for the more delicate species, but also for those which are more robust. However, for the larger specimens, it is recommended that the mounts be built up to contain the mite and support the cover glass. For making such cells, asphaltum rings proved very efficient and practicable.

Mites mounted by both of these methods were clear enough for study in a few hours to several days, depending upon the opacity of the specimens. The consistency can be varied to suit the user. The thicker the medium, the sooner could the examination be made, especially where it is necessary to turn the slide over for study of dorsal and ventral surfaces. The PVA media hardened, as a rule, more quickly than that of Berlese.

Although it is possible to study adult oribatid mites of all species mounted in these two media, no completely satisfactory method of clearing adult specimens of the more opaque species, such as galumnid mites, was discovered. Kates & Runkel found that excellent preparations could be made of these heavily pigmented species by mounting young specimens having all adult features except the deep brown color in the exoskeleton. Hydrogen peroxide has been tried with some success. Galumnids were immersed in a strong solution of hydrogen peroxide for several days and then mounted in the PVA-lactic acid medium. A definite clearing action was noted, and although the setae were not as distinct as before, the overall result indicated that more experimentation with this method might be one answer to this problem.

ORIBATID MITES COLLECTED IN THIS INVESTIGATION.

The classification of mites collected in this ıvestigation follows closely that of Willman 1931), and was used on the suggestion of r. Edward W. Baker.

Order Acari Leach, 1817.
Suborder Sarcoptiformes Reuter, 1909.

UPERCOHORS ORIBATEI DUGÈS, 1834.

COHORS APTYCTIMA OUDEMANS, 1906.

Family Hypochthoniidae.

a. *Hypochthonius rufulus* C. L. Koch, 1835. Text-figs. 1 & 2[1]. (*Hypochthonius ruf., Leiosoma ovata* Nymphe). (Koch, 1835, Fasc. 3, Nr. 19; Michael, 1888, p. 534, Plate 49, Figs. 6-13; Nicolet, 1855, p. 395, Plate 2, Fig. 5).

b. *Trhypochthonius badius* (Berlese), 1904. Text-figs. 3 & 4[1]. (Berlese, 1904, p. 237; Sellnick, 1928, p. 22).

Family Malaconothridae.

a. *Trimalaconothrus angulatus* Willman, 1931. Text-figs. 5 & 6[1]. (Willman, 1931, p. 107, Figs. 46 & 46a).

3. Family Camisiidae.

a. *Nothrus rugulosus* Banks, 1895. Text-figs. 7 & 8[1]. (Banks, 1895, p. 15).

4. Family Neoliodidae.

a. *Platyliodes scaliger* (C. L. Koch), 1840. (Koch, 1840, Fasc. 29, Nr. 11; Sellnick, 1927, p. 27, Figs. 5-9; Sellnick, 1928, p. 24; Willman, 1931, p. 116, Figs. 85a, b).

5. Family Eremaeidae.

a. *Oppia neerlandica* (Oudemans), 1900. Text-figs. 9 & 10[1]. (*Eremaeus n., Dameosoma corrugatus, D. neerlandicum, D. uliginosum*). (Oudemans, 1900, p. 168; Paoli, 1908, p. 62; Willman, 1919, p. 554; Sellnick, 1928, p. 35; Willman, 1928, p. 164).

b. *Oppia splendens* (C. L. Koch), 1840. (*Dameosoma* sp., *Notaspis* sp.). (Koch, 1841, Fasc. 32, Nr. 6; Michael, 1888, p. 393, Plate 33, Figs. 10-15; Paoli, 1908, p. 52, Plate 3, Fig. 15; Sellnick, 1928, p. 35).

c. *Oppia nitens* (C. L. Koch), var. *myrmecophila* (Sellnick), 1928. (*Dameosoma n.* var. *m.*). (Sellnick, 1928, p. 36).

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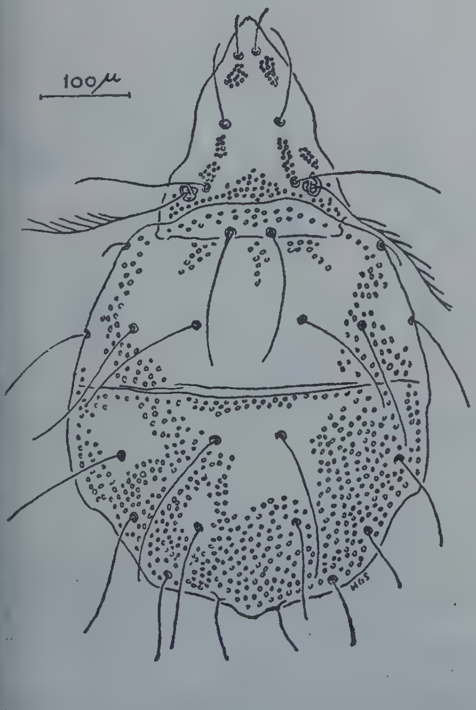
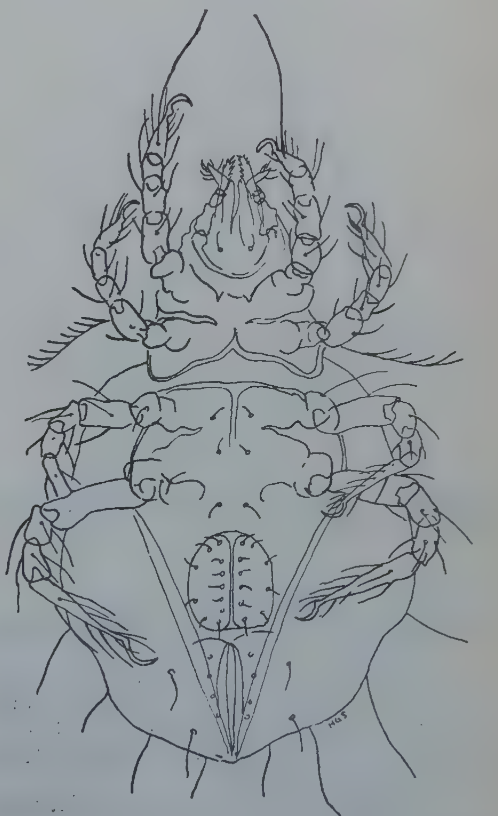
[1] Original camera lucida drawings.

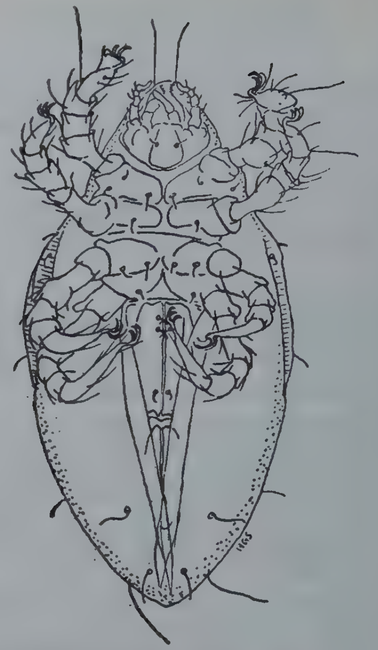


EXT-FIG. 1. *Hypochthonius rufulus.* Dorsal iew. 700μ × 414μ.

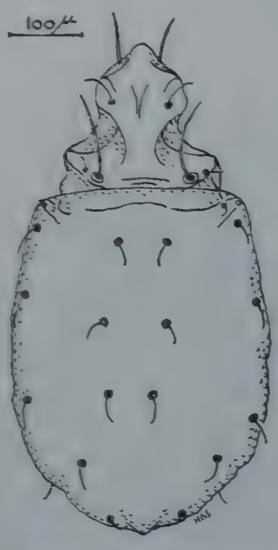


TEXT-FIG. 2. *Hypochthonius rufulus.* Ventral view.

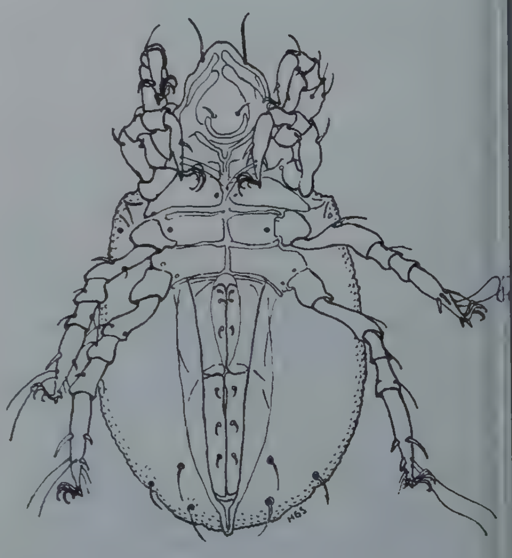
TEXT-FIG. 3. *Trhypochthonius badius.* Dorsal view. 672µ × 350µ.



TEXT-FIG. 4. *Trhypochthonius badius.* Ventr view.



TEXT-FIG. 5. *Trimalaconothrus angulatus.* Dorsal view. 658µ × 358µ.



TEXT-FIG. 6. *Trimalaconothrus angulatus.* Ve tral view.

6. Family Carabodidae.
   a. *Tectocepheus velatus* (Michael), 1880. Text-figs. 11 & 12[1]. (*Tegocranus v.*), (Michael, 1884, p. 313, Plate 31, Figs. 9-15; Berlese, 1895, Fasc. 77, Nr. 2; Sellnick, 1928, p. 28).
   b. *Carabodes areolatus* Berlese, 1916. Text-figs. 13 & 14[1]. (Berlese, 1916, III, p. 333; Sellnick, 1928, p. 29).

7. Family Oribatulidae.
   a. *Oribatula minuta* (Banks), 1896. (*Oribatella m.*). (Banks, 1896, p. 76
   b. *Zygoribatula clavata* (Ewing), 191 (*Oribatula c.*). (Ewing, 1917, p. 162

8. Family Notaspididae.
   a. *Scheloribates latipes* (C. L. Koch 1844. Text-figs. 15 & 16[1]. (*Zetes l., Oribates l.*). (Koch, 184 Fasc. 38, Nr. 14; Berlese, 1888, Fas 30, Nr. 3; Sellnick, 1928, p. 16).

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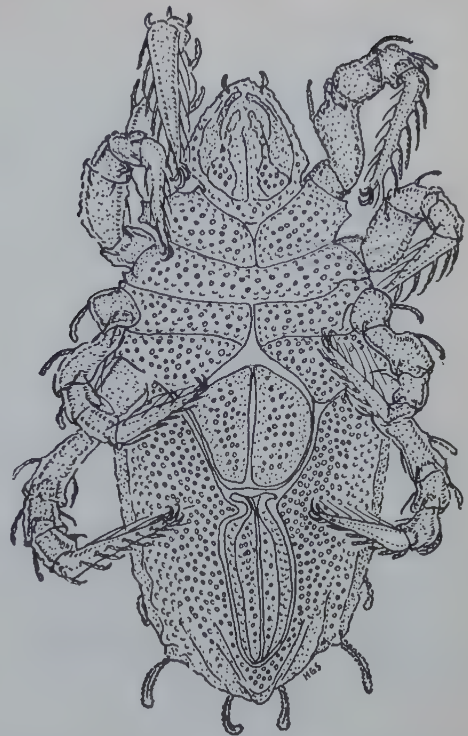
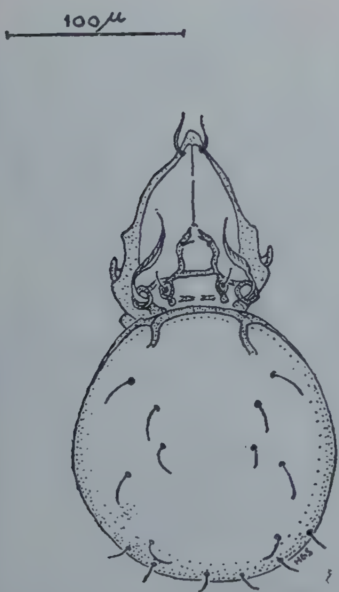
[1] Original camera lucida drawings.

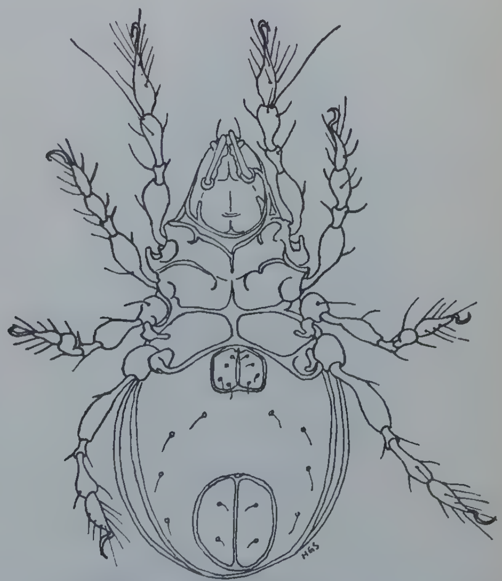
TEXT-FIG. 7. *Nothrus rugulosus.* Dorsal view. 315μ × 400μ.



TEXT-FIG. 8. *Nothrus rugulosus.* Ventral view.



TEXT-FIG. 9. *Oppia neerlandica.* Dorsal view. 257μ × 143μ.



TEXT-FIG. 10. *Oppia neerlandica.* Ventral View.

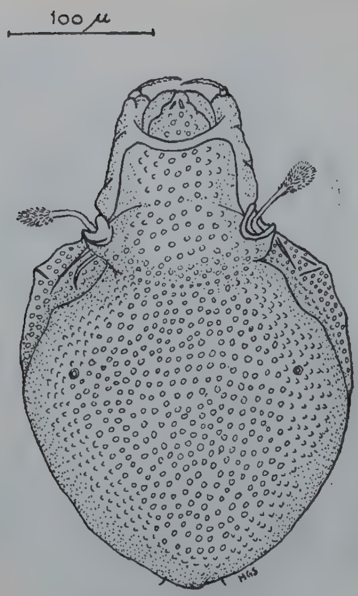
b. *Scheloribates laevigatus* (C. L. Koch), 1836.
(*Zetes l.*). (Koch, 1836, Fasc. 3, Nr. 8; Sellnick, 1928, p. 16).

c. *Melanozetes meridianus* Sellnick, 1928.
(Sellnick, 1928, p. 12).

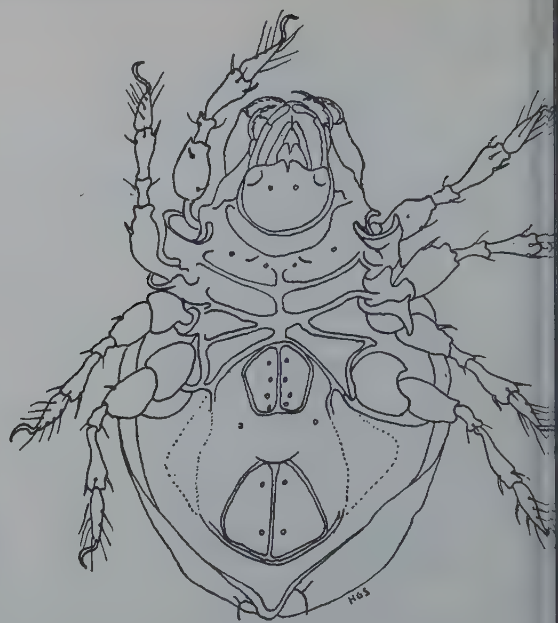
d. *Protokalumma depressum* Jacot, 1933.
(Jacot, 1933, Plate 13).

e. *Galumna emarginatum* (Banks), 1895.
(*Oribata e.*). (Banks, 1895, p. 7).

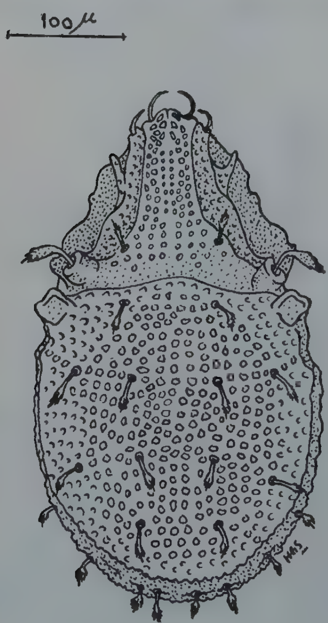
f. *Notaspis punctatus* (Nicolet), 1855.
(*Oribata p.*). (Nicolet, 1855, p. 434,



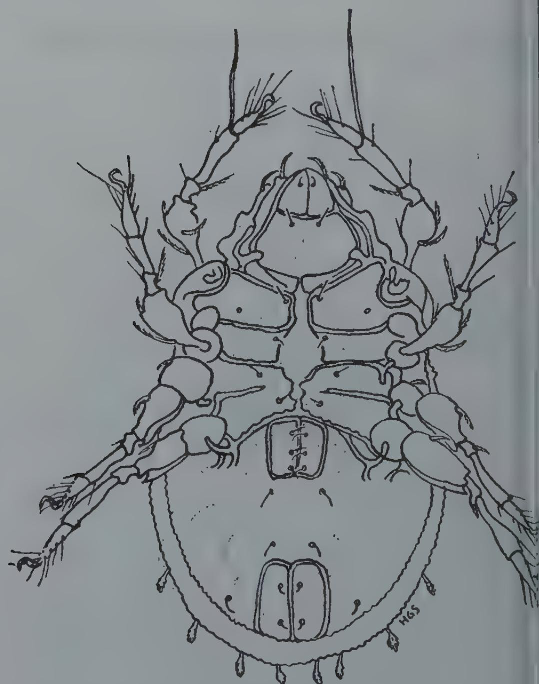
TEXT-FIG. 11. *Tectocepheus velatus.* Dorsal view. 333μ × 214μ.



TEXT-FIG. 12. *Tectocephus velatus. Ventral view*



TEXT-FIG. 13. *Carabodes areolatus.* Dorsal view. 429μ × 257μ.



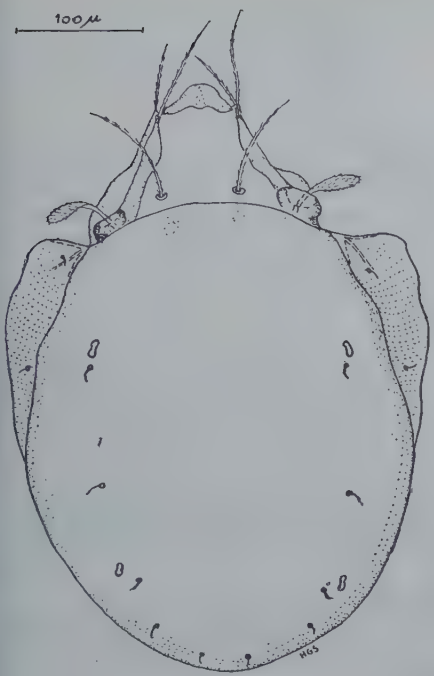
TEXT-FIG. 14. *Carabodes areolatus.* Ventral view

Plate 4, Fig. 7; Michael, 1884, p. 253, Plate 9, Figs. 1-14; Oudemans, 1913, p. 40; Oudemans, 1925, p. 126).

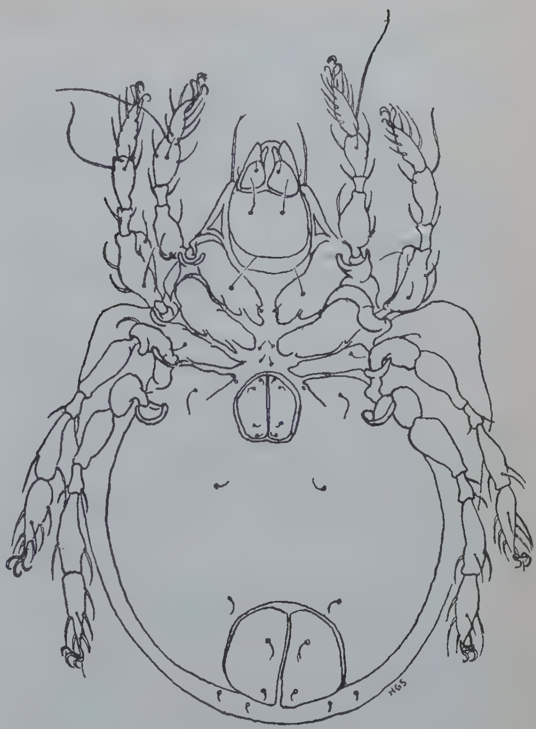
9. Family Haplozetidae.
   a. *Haplozetes* sp. (Willman), 1935. (Willman, 1935, p. 339-340).

COHORS PTYCTIMA OUDEMANS, 1906.

10. Family Phthiracaridae.
    a. *Hoploderma magnum* (Nicolet), 1855 (*Hoplophora m., Phthiracarus m.*) (Nicolet, 1855, p. 472, Plate 10, Fig. 4 Michael, 1888, p. 556, Plate 50, Figs.



Text-fig. 15. *Scheloribates latipes.* Dorsal view. 72μ × 333μ.



Text-fig. 16. *Scheloribates latipes.* Ventral view.

1-7; Berlese, 1892, Fasc. 67, Nr. 9; Oudemans, 1915, p. 218; Sellnick, 1928, p. 40).

b. *Pseudotritia ardua* (Koch), 1841. (*Tritia lentula* ?, *Acrotritia sinensis, P. pectinatus*), (Koch, 1841, Fasc. 32, Nr. 15; Berlese, 1887, Fasc. 36, Nr. 3; Sellnick, 1923, p. 12, Figs. 1, 12, 23, 24; Jacot, 1923; Ewing, 1917; Jacot, 1930, Plate 38, Figs. 44-51).

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11.

Response of a Spontaneous Fish Lymphosarcoma to Mammalian ACTH[1].

PRISCILLA RASQUIN & ETHEL HAFTER.

The American Museum of Natural History.

(Plate I).

INTRODUCTION.

There are relatively few reports in the literature of diseases of lymphatic tissues in teleosts. The lines of experimental investigation which have been pursued in this field have not included any study of the relationship of the endocrine organs to lymphoid disorders.

Dougherty & White (1943, 1945, 1946) have demonstrated a close functional relationship between the pituitary and adrenal cortex and normal lymphoid tissue in mammals. Rasquin (1951) found a similar relationship in the teleost *Astyanax mexicanus*. Heilman & Kendall (1944), Pearson et al. (1949) and Sugiura et al. (1950) have shown that pituitary adrenotropic hormone and some of the adrenal cortical hormones have an inhibitory effect on lymphoid tumors in mammals.

In the light of the pituitary-adrenocortical-lymphoid tissue relationship, it was of interest to ascertain whether a spontaneous lymphosarcoma which appeared in a hybrid characin in this laboratory would undergo any regressive changes after stimulation of the adrenal cortex. A description of the metastasizing lymphosarcoma and its response to the administration of mammalian ACTH is given in this report.

MATERIALS AND METHODS.

Three fish were used for this investigation, all approximately six years old and all laboratory bred. The tumor-bearing fish was a male hybrid, a cross between *Astyanax mexicanus* (Filippi) and a blind cave derivative *Anoptichthys jordani* Hubbs & Innes. The second fish was a female of the same brood used as a normal untreated control. Both these fish showed the same pigmentation as the pure bred *Astyanax* although the eyes were somewhat smaller. As no more fish of this brood were available, the third fish used as an ACTH-injected control was a pure bred male *Astyanax* of the same age.

Three biopsies were made from the growth before injections were begun. The fish was anesthetized with 1% urethane and a piece was cut from the protruding tumor mass. The first biopsy was fixed in Bouin's fluid, sectioned at five microns and the sections were stained with Harris' hematoxylin and eosin, Masson's and Giemsa's stains. The second and third biopsies were taken two and one-half and four weeks later and were used for tissue culture, the results of which will be published subsequently.

Figure 1 is a photograph of the living fish showing the tumor protruding from the left branchial cavity. The photograph was taken 13 days after the third biopsy and prior to ACTH injection. From that day, 12 intraperitoneal injections of 0.1 mg. ACTH in 0.05 cc. of Holtfreter's solution were given, one per day, and one injection of 0.05 mg. in 0.03 cc. of solution was given, making a total of 1.25 mg. ACTH administered. The ACTH was a part of Lot 58-9(50) which had a biological potency of 120% of the Armour standard La-I-A and contained 0.03 units of oxytocin per milligram. The fish was sacrificed 24 hours after the last injection by direct fixation in Bouin's fluid. Immediately after death, the fish was rolled in blotting paper to remove excess moisture and the standard length and body weight were taken. The entire fish was decalcified, imbedded in paraffin and serial transverse sections were cut at five, seven and ten microns and then stained, as were the biopsy sections.

The ACTH used for the control injected fish was a part of Armour Lot 128-105R which had a potency 1.6 times the Armour La-I-A standard. To give a total concentration of ACTH biologically equivalent to the 1.25 mg. given to the tumorous fish, the control animal was given one daily intraperitoneal injection of 0.075 mg. ACTH in 0.05 cc. Holtfreter's solution for 12 successive days. The fish was sacrificed 24 hours after the last injection and the standard length and body weight were taken. This injected control and the normal untreated female control were fixed, decalcified, and imbedded as above. Sections were made of the pituitary region, the head-kidney with adrenal cortex, spleen, liver, pancreas and gonad.

Counts of mitotic figures per 10,000 lymphocytes were made on the injected tumorous

1 This work was supported in part by an institutional grant from the American Cancer Society.

fish from each of the three following regions: (1) the center of the tumor mass, (2) the periphery of the tumor, that is, the part which protruded from the branchial cavity and was equivalent to the tissue used for biopsy, and (3) the growing edge of the tumor directly invading the pharyngeal muscle. A Leitz ocular micrometer ruled in 100 equal squares was used for counting, and only sections cut at five microns and stained with hematoxylin and eosin were used for this technique. The results were compared with similarly-made counts on lymphoctyes in the untreated biopsy. Measurements of lymphocytes across the greatest diameter were made on 50 cells from each of the same regions in the treated fish and compared with measurements similarly made of lymphocytes from the untreated biopsy. Comparisons for statistical significance were made by using the following formula for the derivation of the value of $d/\sigma d$.

$$\sigma d = \sqrt{\sigma M_1^2 + \sigma M_2^2}$$

A Leitz ocular grid micrometer marked off in 100 equal squares was used for making the differential counts of the pituitary cells. Beginning with the first section that contained transitional lobe tissue, all the cells of the transitional lobe were counted in every fourth section through to the end of the transitional area. It was possible to count all the cells within the squared area, and by moving the counting area carefully, to count the remaining fields in the same section without duplicating any field already counted. Therefore no part of the transitional lobe was unrepresented in the final count. The total number of cells represents the number counted in each transitional lobe and is an index derived from counting every fourth section. It is not intended to signify the actual total number of cells in the transitional lobe.

Observations.

The growth when first observed was a gray-white, firm, resilient mass. It was well vascularized and of sufficient size to push the operculum almost at right angles to the body. Biopsy caused little bleeding. About three days after each biopsy the protruding mass had grown back to its original size, appearing first hyperemic, then grayish as melanophores appeared in the periphery. After the third biopsy, the tumor changed somewhat so that it projected posteriorly and ventrally rather than perpendicularly to the body. The fish ate very little, if at all, during the experimental period, but seemed otherwise undisturbed. The appetite of the ACTH-treated control was apparently unaffected by the experimental procedures.

Histologically, the tissue taken at biopsy was composed of small, closely packed lymphocytes supported by a fine reticular stroma. It corresponded to descriptions given for lymphosarcomas of other fishes as well as for lymphosarcomas of mammals described by Boyd (1939) and Ewing (1940).

Although lymph nodes are not found in fishes, regions of lymphoid concentration occur in the intestinal mucosa, spleen, thymus, kidney and head-kidney. Histological examination of the lymphosarcomatous fish showed that the growth originated in the thymus. Direct proliferation of the tumor extended anteriorly to about the level of the optic lobes, involving muscular, osseous, cartilaginous, nerve and epithelial tissues. Direct invasion of the brain or pituitary did not occur although these structures were surrounded by tumor cells in the intercranial spaces. The gills were not extensively involved. Direct proliferation posteriorly did not extend beyond the level of the esophagus and the head-kidney.

The growth was extended by metastases involving to some extent the kidney, corpuscles of Stannius, liver, pancreas, intestine, mesentery and peritoneum. The renal tubules were intact although pycnotic lymphocytes filled the spaces between them and in certain areas caused constriction of the tubules. However, the concentration of lymphocytes in the glomeruli rendered these structures for the most part invisible. The corpuscles of Stannius were heavily infiltrated in some regions. Metastasis to the liver was not extensive, occurring mostly in areas confined about the blood vessels and following the path of the interhepatic pancreas. In a few regions, the lymphocytes had broken up the perivascular arrangement of the pancreatic cells and replaced the glandular tissue. Diffuse portions of the pancreas embedded in the connective and fatty tissue of the mesentery were also surrounded by lymphocytes. The islet tissue was not involved. Although no metatases were found in the stomach, all the layers of the intestinal mucosa were involved to some extent. However, the lumen was not occluded. Metastatic growths were also seen in the mesentery and peritoneum; some regions were heavily infiltrated, while other areas contained only small patches of lymphocytes or none at all. The center of the tumor mass was poorly vascularized and was composed of densely packed lymphocytes lying in the meshes of a delicate reticulum. Some regions of the growth were necrotic and the cells were clumped together, leaving clear spaces around the aggregates.

The results of ACTH injection are divided in two categories: the effects on the tumor tissue, and the effects on normal tissues, both in the tumorous fish and in the ACTH-injected control.

After administration of ACTH, the protruding tumor mass changed in consistency from a firm, resilient mass to a softer, more flaccid one. Sections showed that this was probably a result of edema which appeared mainly in the periphery of the tumor. An

TABLE I.

umbers of Mitotic Cells in the Lympho-
ırcoma Before and After ACTH Treatment.

egion	*% Mitotic figures per 10,000 lymphocytes*
iopsy before CTH treatment	3.38
eriphery of tumor fter ACTH treatment	0.26
enter of tumor fter ACTH treatment	0.48
haryngeal invasion fter ACTH treatment	0.55

brupt shift in staining reaction was exibited by this part of the tumor. The center f the tumor mass was markedly basophilic hen stained with hematoxylin and eosin, ut where the tumor protruded from the perculum the lymphocytes took a strong osin stain while the branchial epithelium hich was stretched far out of normal posiion, stained normally. This protruding part f the tumor, which was equivalent to those ortions cut for biopsy, differed histologially from both the untreated biopsy and the entral part of the tumor. Lymphocytes were ot densely packed. Some areas were very dematous and the reticular stroma was much more clearly seen. Figure 2 is a photograph of a section of the fish through the thoracic area, showing the extent of the tumor and the edematous portion at the periphery. Figure 3 is a photomicrograph under high power of the untreated biopsy which may be contrasted with Figure 4, a photomicrograph of the same peripheral area after ACTH administration. It seems improbable that this result was caused by lymphocytes falling out of the meshes of the reticulum at the time of biopsy, for the administration of ACTH was begun well after the cut edge had healed and the mass had regrown to its original size. Also the change in the consistency of the tumor on palpation occurred only after ACTH administration and not after biopsy.

Pycnotic lymphocytes were frequently seen as well as many others in various states of disintegration, shedding or extruding cytoplasm, or phagocytized by macrophages. These evidences of destruction were found in all parts of the tumor and in all the metastases with the exception of those to the liver and pancreas.

When comparisons are made between the tumor at biopsy and after ACTH-treatment, the lymphocytes in the latter case show a statistically significant decrease in size and numbers of mitotic divisions. Table I shows the decrease in percent of mitotic figures per 10,000 cells from 3.38% in the biopsy to as low as 0.26% in the tumor after ACTH administration. All phases of mitosis were observed in both tissues despite the decrease in numbers of dividing lymphocytes in the treated tumor. Table II shows a significant decrease in the size of the tumor lymphocytes after ACTH administration. The extreme diameters in the biopsy ranged from 3.0 to 5.0 microns as compared with 2.0 to 4.0 microns in the treated tumor.

The greatest effect of ACTH injection on normal tissues was noted in an enlargement of the anterior interrenal cells surrounding the cardinal veins. This tissue has been shown to be homologous with the mammalian adrenal cortex in this species (Rasquin, 1951). In both ACTH-treated fishes, individual cortical cells were greatly hypertrophied and cords of hyperplastic cells could

TABLE II.

Comparison of Lymphocyte Diameter for Statistical Significance Before and After ACTH Treatment.

Region	*Mean Lymphocyte Diameter in microns*	*Standard Deviation*	*Standard Error*	*Significance*
Biopsy before ACTH injection	4.04	.598	.08458	7.0
Center tumor mass after ACTH injection	3.29	.458	.06478	
Biopsy before ACTH injection	4.04	.598	.08458	4.5
Pharyngeal invasion after ACTH injection	3.46	.699	.09887	
Biopsy before ACTH injection	4.04	.598	.08458	6.5
Periphery of tumor after ACTH injection	3.34	.463	.06549	

be seen extending into the lumen of the cardinal vein as well as spreading into the parenchyma of the head-kidney. Granules which stained with methylene azure were seen within the cortical cells in Giemsa-stained sections. These basophilic granules were not specifically located in the cells either with respect to the nucleus or to the lumen of the blood vessel. They were not seen in the cortical cells of the normal untreated control.

Changes in the lymphoid tissues, whether normal or malignant, were undoubtedly a result of the stimulated cortical tissue. Most of the normal lymphocytes in the head-kidney showed greater destructive changes than did those tumor cells that had proliferated directly to this organ from the adjacent tumor mass. The parenchyma of the head-kidney of both ACTH-injected fishes appeared pitted with edematous areas and regions of greater or less lymphocyte concentration. Most of the lymphocytes had pycnotic nuclei and many had been phagocytized by macrophages. None of the cells of the hemopoietic series of either ACTH-injected fish showed any dividing forms. The head-kidney of the untreated control appeared normal; occasional mitoses were observed in the hemopoietic cells and there was less vascularization than in the injected fishes.

The spleens of both treated fishes were almost completely depleted of lymphoid elements. The vascular sinuses or pulp spaces were so engorged with mature red blood cells that superficially the organ appeared to be only an open sinus filled with blood. Close examination showed slender trabeculae from the capsule to be intact. Some small pycnotic lymphocytes were found concentrated in a ring around the periphery. The spleen of the untreated control fish showed the normal condition characterized by the presence of lymphoblasts and small lymphocytes, phagocytes and various types of granulocytes lying as irregular aggregates in the pulp, or arranged concentrically about the thick-walled ellipsoids, those arterioles common to the spleens of fishes.

The thymus in the tumor-bearing fish had been completely obliterated by the growth. The thymus of both the normal and ACTH-injected controls had undergone age involution and no apparent difference in degree of atrophy was discernible between them. The thymocytes, however, of the ACTH-injected control, were pycnotic and in some regions were clumped together in dense necrotic aggregates in contrast to the normal thymocytes of the untreated control.

No metastasis was observed in the testis of the lymphosarcomatous fish. In both ACTH-treated fishes, the sperm duct epithelium was greatly stimulated, giving the appearance of increased secretory activity. Spermatogenesis appeared normal in the tumorous fish, but was tremendously stimulated in the ACTH-injected control where the testicular lobules were completely filled with mature sperm.

The results of the differential analyses of the pituitary cells are given in Table III. According to work previously reported by Rasquin (1949, 1951) the proportion of cells shown by the two control fishes were normal for the sexually mature adult of the species. Histological study of the pituitary of the tumor-bearing fish indicates that the abnormal proportion of cells was a result of the loss of basophiles and not of an increase in acidophiles. In all three fishes the anterior lobes of the pituitaries were intact; the nuclei and cytoplasm were normal in form and granulation. The function of this part of the teleost pituitary is at present unknown. The transitional lobes, that are homologous to the mammalian anterior pituitary, showed excessive vacuolation of the basophiles. Granules differed in size and were clumped. Small sinuses or lacunae were present that appeared to have been formed by the union of adjacent vacuolations. In the tumor-bearing fish this process had advanced to such a state that the transitional lobe contained large numbers of lacunae and one had assumed such large proportions that it occupied approximately ⅛ to ¼ of the area of the sections. It was filled with an acellular granular debris. Retrograde changes were also seen in the intermediate lobes of all three fishes.

Discussion.

Schlumberger & Lucké (1948), in a review of tumors of cold-blooded vertebrates, have described lymphosarcomas in 20 fishes and in a complementary paper the same authors (1949) reviewed the lines of experimental investigation which have been pursued. Five of these lymphosarcomas were non-metastatic. Two were reported by Johnstone, one arising in the eye of a female flounder, *Pleuronectes flesus* (1912), and the other in the body cavity of a herring of undetermined sex (1926). Another was described by Williams (1931), having its origin in the kidney of an adult female conger eel. Two more were reported by Haddow & Blake (1933), arising in the kidney of the salmon, *Salmo salar,* and at the base of the fins of a pike, *Esox lucius*. The work of Haddow & Blake was abstracted by Schlumberger & Lucké (1948).

The remaining descriptions of fish lymphosarcomas are all of metastatic tumors. Plehn (1924) described such a tumor originating in the kidney of a goldfish, which not only caused extensive damage to that organ but metastasized to the enlarged liver. Smith, Coates & Strong (1936) reported a lymphosarcoma from one *Rasbora lateristriata* which they believed had originated from lymphatic tissue near the peritoneum and which showed involvement of the roof of the oral cavity, the gills, the base of the brain and the left auditory sacculus. Nigrelli (1943)

TABLE III.

Standard Lengths and Weights of the Fishes and Statistical Analysis of the Cells of the Transitional Lobes of the Pituitaries.

	Lymphosarcomatous ACTH-injected fish	*ACTH-injected control fish*	*Normal untreated control fish*
tandard length in centimeters	6.7	7.1	—
Veight in grams	8.5	7.1	—
otal cells counted 1 pituitary	13,837	43,259	15,876
6 pituitary asophiles	46.3	68.5	65.8
6 pituitary cidophiles	52.1	29.9	32.6
6 pituitary hromophobes	1.6	1.6	1.6

947) described spontaneously occurring ymphosarcomas in 12 adult northern pike, *Esox lucius*. Both sexes were represented in this number. The tumor originated in the kidney where massive growths were characterized by lymphoblast-type cells supported by a reticular and fibrous stroma. Metastases occurred in the liver, spleen and retroperitoneal tissues.

Nigrelli (1947) also described an isolated case of lymphosarcoma in a four-year-old male *Astyanax mexicanus*. The fish appeared exophthalmic and the branchial region was enlarged. The swollen appearance was caused by a large mass of typical lymphoid cells which originated in the thymus-like lymphoid gland. There was considerable local proliferation as well as metastases to the skin, gills, submucosa of the intestine, liver, pancreas, kidney, spleen, testis and retroperitoneal tissues. This tumor occurred in one of the parental species of the fish with which the present report is concerned, and originated from the same organ. Slides kindly loaned to the authors by Dr. Nigrelli show the two tumors to be identical histologically. Four of these tumors have arisen spontaneously among approximately two thousand *Astyanax* bred in the laboratory. Three occurred in adult males, one in an adult female.

Various adrenocortical preparations as well as pituitary adrenocorticotropin have been used experimentally on mammalian lymphosarcomas. Compound E, used by Heilman & Kendall (1944), not only prevented development of the tumor in a 100% susceptible inbred strain of mice, but also, when administered in larger doses, caused marked regression of large tumors. The sex of the animals influenced the response of the tumor to Compound E. Female and young male mice showed quick and complete tumor absorption, whereas adult males responded only if estradiol propionate was administered simultaneously with Compound E, or if the mice were castrated. Sugiura et al. (1950) also found that Compound E markedly inhibited experimental mouse lymphosarcomas, but no sex difference in the response of the tumor was reported. Pearson et al. (1949) reported regression but not complete clinical remission with ACTH therapy in lymphoid tumors in man.

The structural similiarity between tumors in cold-blooded vertebrates and corresponding tumors of warm-blooded animals is well known. The inhibition of a fish lymphosarcoma by ACTH indicates a similiarity of physiological response between the fish and mammalian tumors. The dosages of ACTH used were necessarily arbitrary and it is conceivable that a more striking regression might have occurred had a greater amount of the hormone been employed.

The stimulation of the testis by ACTH administration is contrary to the results obtained by Baker et al. (1950). Such stimulation of the gonad would normally be associated with the administration of gonadotropic hormones. Since the ACTH supplied was contaminated only with a small fraction of posterior lobe hormone, the indication is either that the fishes did not react as specifically to the adrenocorticotropin as mammals do, or that the stimulated adrenal cortex elaborated androgenic substance.

The increased vacuolation in the transitional lobes of the pituitaries was probably associated with old age. The cytological changes were shown by all three fishes and old age was a common factor among them. The index of the total numbers of cells shown by the tumorous fish and the untreated control is common in this species, but the enormous number shown by the ACTH-injected control is unexplained since the gland showed no evidence of hyperplasia. It has been shown (Rasquin, 1951) that in normal fish, single injections of ACTH did not change the proportions of basophiles to acidophiles and chromophobes in the pituitary transitional lobes. This unaltered proportion also was noted here in the ACTH-treated control after repeated injections. It

therefore seems likely that the abnormal proportions of cells in the tumorous fish existed before ACTH treatment. Whether or not the lower per cent. of basophiles is associated with the etiology of the tumor is unknown.

Koneff (1944) found that continued administration of ACTH caused changes in the basophiles of the rat pituitary indicative of a depressed activity, while the acidophiles were unaltered. Also working with rats, Tuchmann-Duplessis (1950) found degranulation of both acidophiles and basophiles after adrenalectomy, and decrease in size and staining reaction of basophiles after ACTH administration. Hypertrophy and rich granulation of basophiles was noted after DCA administration. When assayed biologically, the hypophyses of animals rich in basophiles were reported to contain twice as much hormones as those of adrenalectomized animals. Rasquin (1951) has shown in younger *Astyanax* some indication of a decrease in total number of transitional lobe cells after a single injection of ACTH, suggestive of depressed activity. A study of the effects of adrenocortical stimulation on the pituitary of *Astyanax* is in progress.

Summary.

A six-year old male hybrid *Astyanax-Anoptichthys* bearing an extensive and metastatic lymphosarcoma was subjected to 12 daily injections of 0.1 mg. ACTH. Three biopsies were taken from the tumor before injection was begun. Two controls were used. One was a normal untreated female broodmate and the other was a six-year old male *Astyanax* subjected to the same injection routine.

Inhibition of the tumor after ACTH injections was shown grossly by a softening of the firm, resilient tumor mass. Histological examination showed edematous spaces and cellular debris in parts of the tumor. There was a marked decrease in the numbers of mitotic figures and a significant decrease in size of the lymphocytes of the tumor as compared with the untreated biopsy.

The adrenal cortex was hypertrophied in both ACTH-injected fishes. The lymphoid tissue of the head-kidney was in a state of disintegration and no mitotic figures were seen in the hemopoietic cells. The spleen was depleted of all lymphoid elements. The untreated control was normal in these respects.

All the fishes showed destructive changes in the hypophyses which were attributed to old age. Only the tumor-bearing fish showed an abnormal differential cell count in the pituitary, associated with a reduction in number of basophiles.

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EXPLANATION OF THE PLATE.

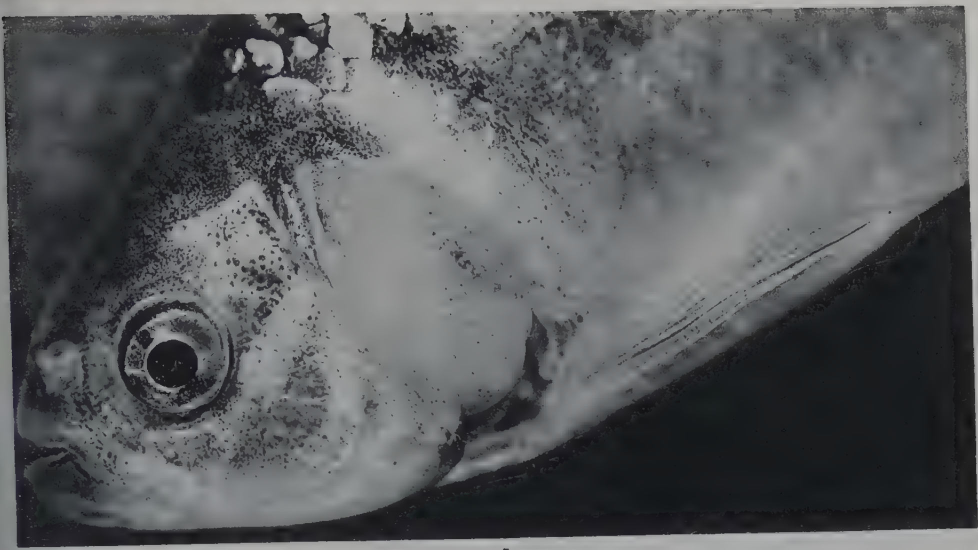
PLATE I.

Fig. 1. Photograph of the living fish prior to ACTH injections, showing the tumor protruding from the branchial cavity. The operculum has been deflected outward and forward by the tumor mass so that it is vertical to the plane of the photograph. Magnification 4×.

Fig. 2. Photomicrograph of a transverse section through the thoracic region of the fish, showing the extent of the tumor and the edematous periphery after ACTH administration. Magnification 83×.

Fig. 3. Photomicrograph of the untreated biopsy. Three mitotic figures are seen in the center of the field. Magnification 1000×.

Fig. 4. Photomicrograph of the peripheral region of the tumor after administration of ACTH. Magnification 1000×.



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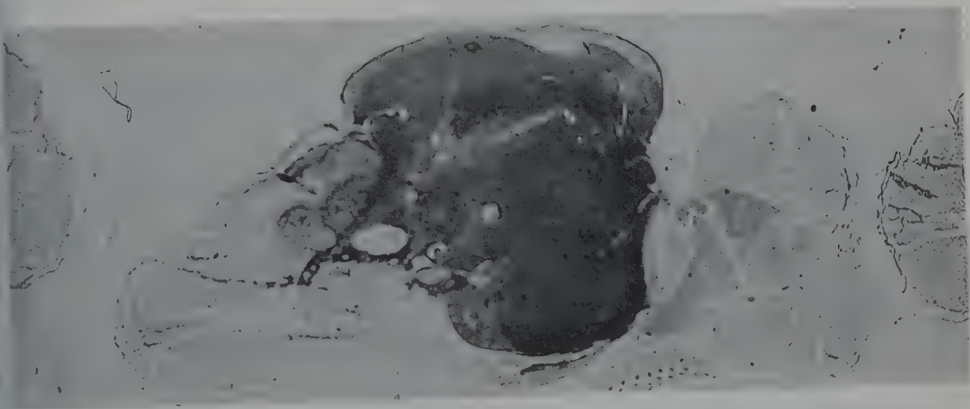

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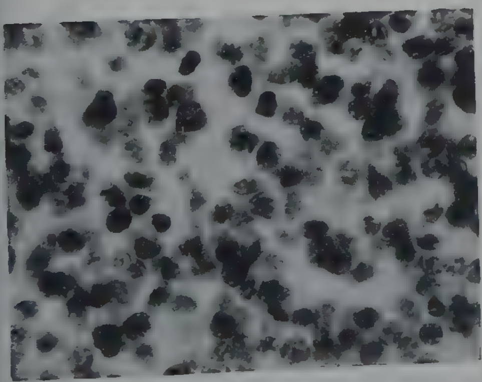

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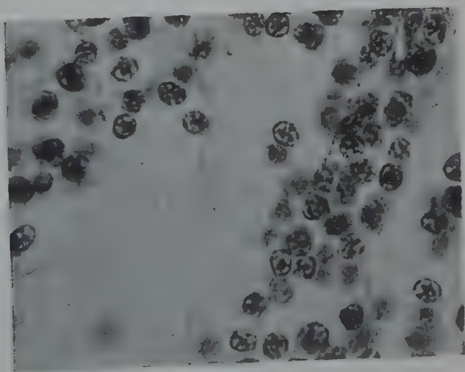

4

RESPONSE OF A SPONTANEOUS FISH LYMPHOSARCOMA TO MAMMALIAN ACTH.

12.

A Study of the Social Behavior of a Captive Herd of Giant Tortoises.

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American Museum of Natural History & Manhattan College.

(Text-figures 1-4).

Introduction.

This study of the social behavior of the giant tortoise, *Testudo elephantopus*, was made to discover whether any hierarchical social structure existed in the herd of 14 Galapagos tortoises at the New York Zoological Park. These particular animals were favorable subjects for a psychological study because they had lived together a long time and their environment at the Park was relatively static.

Van Denburgh's report (1914) sheds important light upon the habits of these great tortoises in their natural haunts. The following excerpts are taken directly from his monograph. ". . . When I landed at Chatham Island, . . . near the springs, it was a curious spectacle to behold many of these huge creatures, one set eagerly travelling onward with outstretched necks, and another returning, after having drunk their full. . . . The inhabitants say each animal stays 3 or 4 days near water, and then returns to the lower country; from observing marked individuals, they say the tortoises travel a distance of about 8 miles in 2 or 3 days. One large specimen which I watched, walked at the rate of 60 yards in 10 minutes, that is 360 yards an hour, or 4 miles a day, allowing a little time for it to eat on the road.

"Most travelling is done early in the morning and late in the afternoon, the hot hours of noon being spent in the shade of a bush, wallowing in the damp soil. . . . All of the species we observed make seasonal vertical migrations. Soon after the rainy season starts they descend the mountains to the grass-covered flats at their bases to feed and deposit their eggs in the light soil. After the grass is withered, they again ascend the mountains to the moist meadows produced by the trade winds at an elevation of 2,000 feet and above.

"These migrations are most marked in the dry regions, as at Tagus Cove, Albemarle Island; but even at Iguana Cove (same Island), where there is an abundance of moisture at lower elevations, a nearly complete migration takes place. . . . In their seasonal pilgrimages they follow well established trails used perhaps for generations. These trails radiate from the higher plateaus as a center and usually follow the floors of the canyons to the flats below. Some of the trails are of considerable length, requiring several days of persistent effort on the part of the tortoise to cover them." Beck (1903) confirms Van Denburgh's description of the habits and environment of these huge creatures.

Most herpetologists agree that all Galapagos tortoises belong to one species, *Testudo elephantopus*. Those found on the different islands of the archipelago represent subspecies. Because of the close resemblance between *T. elephantopus* and the large South American tortoise, *Testudo denticulata*, it is believed that the mainland form was transported to the islands on floating trees in the wake of the prevailing westerlies, countless centuries ago.

Townsend (1925) has shown that tremendous numbers of turtles existed at one time on the Galapagos Islands. Several lines of evidence indicate that the animals moved in herds. The deeply worn trails, only wide enough for one animal to pass, radiate in all directions downward from the higher elevations. The tortoises travelled these trails in tandem fashion, one behind the other. This enforced a type of social hierarchical rating, since only one individual could lead a herd and each member of the group had to keep its place in line or actually prevent those behind from passing, in many parts of the trail. In other words, the social behavior of the species was modified in response to the very rocky terrain. The present study attempted to determine whether the same social patterning, or a modification, is reflected by individuals in captivity.

Procedure and Description.

Prior to 1946 the New York Zoological Park herd consisted of eight specimens. Two of these, a male (designated as YO) and a female (designated as YD), were from the Aldabra Islands. The remaining six tortoises were originally from the Galapagos Islands.

[1] In these experiments the authors had the assistance of D. Burckhardt and J. A. Murnin who, with the authors, held Animal Behavior Fellowships of the New York Zoological Society for the summer of 1949. See abstracts of papers read by the Fellows before the Animal Behavior and Sociobiology Section of the American Society of Zoologists, December 28, 29, 30, 1949, in *Anat. Rec.*, vol. 105, no. 3, pp. 25-31, 98-102. Wholehearted cooperation was received from the late Brayton Eddy, Curator of Reptiles at the New York Zoological Park; Keeper Earl Chace and Staff Photographer Sam Dunton. The senior author wishes to thank also Mr. Charles M. Bogert for helpful advice.

TABLE 1.

Physical Measurements of Giant Tortoises (October 14, 1949).

Species	Name	Sex*	SL†	CL	SW	CW	Height	Wt. lbs.	No.
T. e. vicina	RO	m	39	52	29	48½	20	343½	146
"	RX	m	40	53	29½	53	23	331½	186
"	RT‡	m	42	53	29	54	22	328½	128
"	R=	m	34	46	26	48½	18	268	162
"	Y=	f	31	43	24	44	17	210¼	180
"	RD	f	28	40	22	43	16½	196	83
"	YX§	f	23	28	18	34	13	92½	A3
T. e. vandenburghi	BT	m	37	50	23	49	18	275½	A6
"	BO	m	33	45	24	43½	18	241½	A7
"	YT	f	27	37½	20	37	16	150	A8
T. e. ephippium	RH	m	26	30	19	31	12	111	A5
"	BX	m	23	28	18	27½	11½	81½	A4
T. e. aldabra	YO	m	32	36	24	38	11	182	A1
"	YD	f	30	41	21	42	14	168	A2

* The male has a concave plastron and its tail is longer than that of the female.
† SL—Straight length of carapace in inches.
CL—Curved length of carapace in inches. (Measured over the curve of the carapace).
SW—Straight width of carapace in inches.
CW—Curved width of carapace in inches. (Measured over the curve of the carapace).
Height—in inches.
‡ RT—Weight at death, December 3, 1949, was 307 pounds.
§ YX—*T. e. nigra*.

Two of these were so-called saddle-back males, *T. e. ephippium* (RH and BX). Three, two males and a female (BT, BO, and YT), belonged to the *vandenburghi* subspecies. The sixth specimen, a female (YX), was *T. e. nigra*.

In 1946 the Curator of Reptiles, the late Mr. Brayton Eddy, brought 6 specimens of *T. e. vicina* from Florida. These comprised four large males (RT, RX, RO, and R=) and two females (RD, and Y=), part of a herd of 180 giant tortoises brought from the Galapagos in 1928 by C. H. Townsend, then Director of the New York Aquarium.

Since the arrival of the *vicina* specimens at the Park, they have been housed with the other eight tortoises at the Reptile House. The entire herd of 14 was fed and watered together and enjoyed the same exercising yard and sleeping quarters.[2] On December 3, 1949, a large male, RT, died. Autopsy revealed a mass of unchewed carrots in the intestine, which might have caused an obstruction to the passage of food. Table 1 gives the physical measurements and permanent number of each specimen studied.

The degree of sociability[3] of the herd was noted by recording, by means of diagrams, the positions which individual tortoises took with reference to other individuals in the following four habitual resting situations: at evening rest in the shelter, or P pattern (for P.M.); at morning rest in the shelter, or A pattern (for A.M.); when clustered around the piles of lettuce outside the shelter, or L pattern; and while sunning, or S pattern.

Daily records of these four categories of social contacts were kept for an average of 28 days. In addition, an average of 40 daily records were preserved of the order in which each animal entered the shelter for the night and emerged from the sleeping quarters in the morning. Instances in which individuals failed to enter the shelter in the evening voluntarily, or remained inside in the morning, were likewise tabulated.

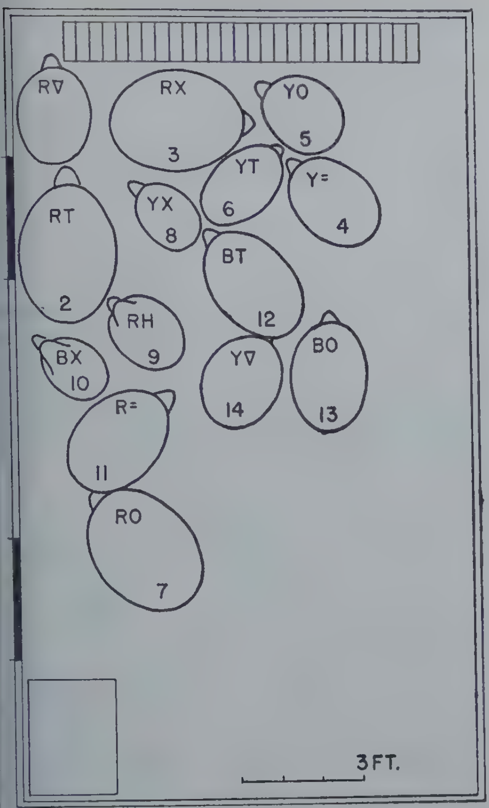
For the safety of the herd it was necessary to lock it in the shelter each night and those animals which failed to go in of their own accord by 4:30 P.M. were gently urged inside by the keeper. Half an hour was allowed for the herd to settle down, after the door was closed, before the evening rest pattern was recorded. Occasional inspections as late as 10 P.M. showed virtually no change from the 5 P.M. pattern. The commonest change recorded in this interval was a partial rotation of the animal on its own axis so that it faced another direction, but remained in essentially the same relation to its shelter mates.

Text-figure 1 depicts the actual evening rest pattern on July 7, 1949, and the morning rest pattern of July 8, 1949. It is a typical example and displays many social contacts characteristic of individual animals. The

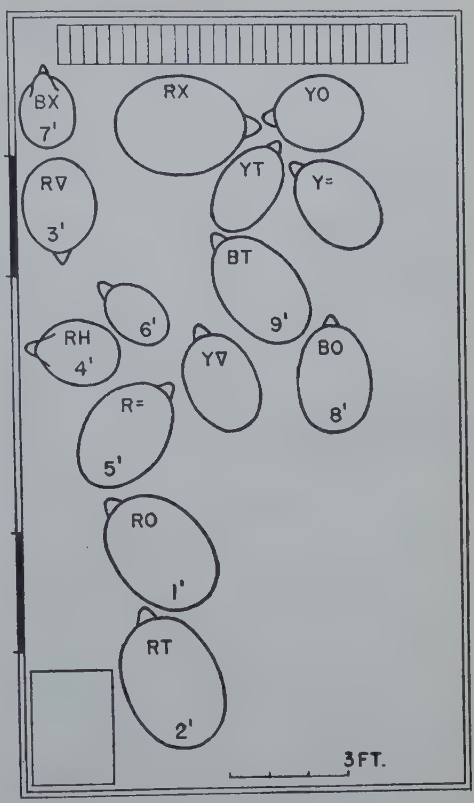
[2] The summer sleeping quarters in the shelter measured 19 feet 6 inches by 14 feet 2 inches. The winter housing was the same for the eight large specimens, while the adjoining inside corral accommodated the six small specimens (YD, YT, RH, YX, BX, YO). The outside yard was 43 feet 4 inches by 26 feet 2 inches, with the south end rounded. Winter temperatures (below about 63°F.) make it necessary to provide heated quarters indoors for these giant reptiles between the months of October and April.

[3] The term "sociable" or "social" as used in this report denotes an endogenous urge on the part of one tortoise to be close to another. It does not refer to sexual or fighting contacts. To eliminate as many random meetings or contacts as possible between individuals, only those contacts were recorded that occurred when two animals were together, their shells touching or a few inches apart, in an attitude of rest with plastrons on the ground.

P. M. Rest Pattern



A. M. Rest Pattern



TEXT-FIG. 1. The actual evening and morning rest patterns of July 7 and July 8, 1949, respectively. The carapaces of the herd are shown in correct scale with reference to the size of the shelter and to each other. The numerals on each tortoise in the P. M. Rest Pattern indicate the order in which each entered the shelter in the evening; those on nine specimens in the A. M. Rest Pattern indicate the order of exit in the morning. The remaining five tortoises left the shelter about an hour later.

The contacts recorded on these two specific occasions are given to illustrate the technique adopted in recording all the contacts as given in Table 2.

P pattern: RD-RT, RD-RX, R=-RO, BT-BO, BT-YT, YD-BO, R=-YX, YO-Y=, Y=-YT, R=-RH, RT-RH; these 11 were significant (see Table 2). The following proved to be random (see Table 2): R=-BX, BX-RH, YX-YT, YX-RX, YT-YO, RX-YT, BT-YD, RX-YO.

A pattern: RT-RO, R=-RO, R=-RH, BT-YT, BT-BO, R=-YX; these were significant (Table 2). The following were random contacts (Table 2): R=-RH, YX-RH, BX-RD, RX-YT, RX-YO, Y=-YO, Y=-YT, YD-BT, YD-YX. The grill at the upper end of each diagram represents the radiator.

outlines of the carapaces of the several members of the herd are shown in correct scale with reference to the size of the shelter and to each other. In the diagram of the P.M. Rest Pattern, the number on each carapace denotes the numerical order in which each tortoise entered the shelter via the door at the lower left, near the rectangular water pan. In the diagram of the A.M. Rest Pattern, the numbers, primed, on nine individuals, indicate the order in which they emerged from the shelter when the door was opened on the following morning. Five members of the herd failed to leave the shelter until very much later in the day, when they were gently urged out by the keeper before he proceeded to clean the shelter. Almost all defecation occurred indoors, usually early in the morning.

Text-figure 1 summarizes graphically the habitual behavioral traits of several members of the herd. By comparing the P and A patterns it will be observed that RD was the first to enter the shelter on this particular evening, that she chose the left hand corner by the radiator, and that she left the shelter in third place. To do so she had to thread her way around and perhaps over certain other animals.

RT entered in second place, coming to rest immediately behind RD. In the morning he moved to the water pan, indicating that he climbed over or shoved his way between individuals to reach his goal. RT left the shelter also in second place, directly behind RO.

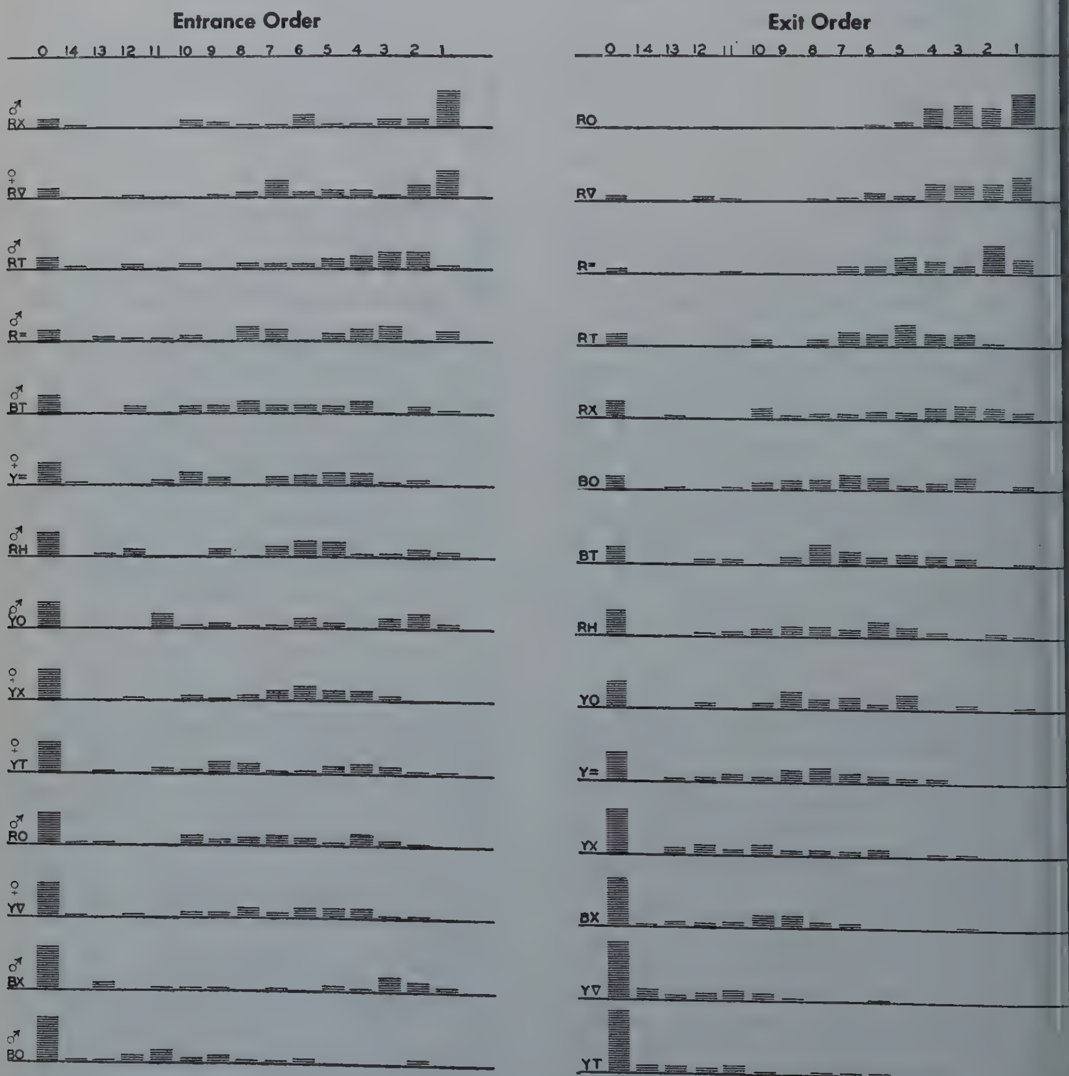
RX entered the shelter in third place, resting next to RD, against the radiator. RX usually sought the left hand corner but on

this particular evening RD reached it first. RX made almost no change in position during the early morning hours and did not leave the shelter until urged by the keeper.

RO's morning position was relatively unchanged from that of the evening position. RO habitually entered the shelter after many or most of the others had done so or after being prompted by the keeper. RO invariably came to rest by the exit door. On July 8 he departed in the morning in first place.

Although RO and BO preferred to enter the shelter after most of the others had done so, the numerical order of exit of each was quite different. RO left habitually in first place; BO habitually rested by BT and departed usually in sixth place, after most of the largest tortoises had done so. The relative positions of the other members of the herd in Text-figure 1 will not be analyzed at this point but the relative sociability of a[...] the herd will be examined later.

Text-figure 2 depicts the actual perform[...]ance of each member of the herd with refe[...]ence to the numerical order of entrance an[...] exit for a total of 40 and 42 days, respe[...]tively. The vertical column marked "O" rep[...]resents the number of failures of any ind[...]vidual to enter or leave the shelter of its ow[...] accord. Text-figure 2 especially emphasize[...] the following: 1. Individuals that are prom[...] to enter or leave early in numerical orde[...] show relatively few failures to enter or leave[...] there are cases, however, in which a tortois[...] entered early in numerical order but d[...]parted late; such an individual usually ha[...] more failures in departure than in entrance[...] The reverse would apply to a tortoise whic[...] entered late but emerged early. 2. Tortoise[...] that habitually enter or leave late in numer[...]



TEXT-FIG. 2. Depicts the number of times each member of the herd entered or left the shelter during 40 evenings and 42 mornings, respectively, in each of 14 possible numerical positions of precedence. The columns marked "0" recor[...] the number of times each individual failed o[...] its own accord to enter by 4:30 P.M. or to leav[...] by 10 A.M.

al order show many failures to enter or merge. 3. There was greater consistency on ne part of individuals in the exit order than n the order of entrance. This was in part ue to the greater number of distractions utside the shelter in the afternoon than inide in the morning. There was also a growng urgency to be active after a night's sleep nd perhaps to escape the nightly accumulaion of excreta.

Specific examples may be cited in connecion with Text-figure 2. It has been menioned that RO was prompt to leave the shelter; this is correlated with the fact that he tayed near the door while inside. He was aturally in a favorable position to emerge irst, which he did on 14 mornings. During he remaining 18 mornings his numerical rder of exit was never greater than sixth nd was usually second, third or fourth. RO never had to be urged out by the keeper. In contrast, RO usually entered the barn in eleventh place and on 13 evenings he failed o enter by 4:30 o'clock.

RX seemed to be particularly anxious to enter the barn early in the afternoon. Textfigure 2 indicates that although he ranked fifth in order of exit, he ranked first in order of entrance, having preceded the herd on 15 evenings and failing to enter a minimum of four times. RX was a dominating male and generally managed to secure his share of food by merely shoving in and taking it. Others in the group usually withdrew when RX reached for a morsel.

RD was surprisingly consistent in both her entrance and exit patterns, ranking second in both. She was either very sociable or restless, settling down with one group or individual, then with another, then with a third; subsequently she would enter the pool, drink deeply, crawl out and walk along the fence. She seemed to have a rather aggressive attitude toward others; she rarely yielded or retired in favor of any but the three largest males.

RT followed a surprising pattern. He regularly followed RD or RX in and followed RD, RO or R= out of the shelter. Thus RT was rarely first in or out, but was apt to enter or leave the shelter early in the numerical order. RT not only followed RD or RX in, but chose to rest immediately next to one or the other throughout the night.

R= behaved like RT but with slightly less consistency. This male habitually followed RX and RD into the shelter and emerged in the morning usually immediately after RO or RD. Like RT, R= found satisfaction in being with the individuals mentioned. When they moved from sight, he exhibited a strong urge to go to them.

The actions of the two big males of the *vandenburghi* race deserve attention. It will be noted that their numerical order of exit is similar. Each male was closely observant of the other and also of the larger *vicina* tortoises. The *vandenburghi* males rarely left the shelter before the latter did so and then BO usually preceded BT in his exit.

The entrance pattern of BT and BO was quite different. BT entered the barn after most of the larger tortoises had done so, usually in fifth place. BO, on the other hand, either failed to enter without urging by the keeper or else very late in numerical order. He seemed to be particularly responsive to the crowds of visitors passing the outside pen just before the Zoological Park's closing time. He stayed near the fence and kept busy eating the sweetened popcorn tossed to him.

The numerical order of entrance and exit of the two saddle-back males was quite different. While RH was usually seventh in and eighth out, BX was thirteenth in and twelfth out. The numerical positions of these tortoises are, no doubt, a reflection of the antagonistic behavior of RH toward BX. The former would raise his head, open his beaklike jaws, and stalk slowly toward BX whenever the latter approached. BX invariably retreated.

The first place position of RO in the Exit Order (Text-fig. 2) and his position in eleventh place in the Entrance Order relates closely to the degree of sociability recorded between RO and RT, RX, R= and RD, in the P and A patterns (Table 2). It will be observed that of a total of 149 social contacts between these five individuals in the A pattern, 65, or 43%, were between RO and the other four, while in the P pattern only 83 were recorded and of these only 14, or 16.6%, were between RO and one other, the association being RO-R=.

It is apparent that the tardiness of RO to enter the shelter at night, as well as his habit of sleeping close to the door, separated him from the other four in the P pattern. In the morning the others shoved between and climbed over intervening animals to come to rest close by RO, in the A pattern. When the door was opened RO usually crawled out first, followed closely in order by RD, R= and perhaps even RX, and only then by RT.

When RX entered the shelter first, which he usually did, he was able to occupy his favorite corner. RD followed immediately, or less usually preceded RX. RT consistently followed RD or RX, preceding them only once in 40 evenings. R= rather habitually followed RT, and RO entered about eleventh in line. As each tortoise entered it moved resolutely to its accustomed sleeping spot, RD immediately beside RX (19 times), RT beside RX (22 times), R= immediately behind RT (14 times) but not near RD or RX, and finally RO immediately behind R= (14 times), with male RO resting close to the door.

Table 2 records every contact made between each of the 14 tortoises with every other member of the herd for a total of 28 days, for each of the four resting patterns (P, A, L, S). In analyzing these data it is necessary to distinguish random contacts between individuals from contacts resulting

TABLE 2.

Total Number of Contacts During 28 Days Between All Tortoises in Each of Four Rest Patterns.

	Pattern	RT	RX	RO	R=	RD	Y=	YX	BT	BO	YT	RH	BX	YO	YD
RX	P	22													
	A	16													
	L	7													
	S	13													
RO	P	6	4												
	A	22	17												
	L	8	8												
	S	20	14												
R=	P	14	7	14											
	A	17	15	15											
	L	11	6	8											
	S	17	17	13											
RD	P	14	19	5	4										
	A	14	11	11	11										
	L	8	8	5	6										
	S	9	16	15	9										
Y=	P	18	10	11	14	7									
	A	12	13	9	16	9									
	L	5	3	6	9	8									
	S	7	11	7	11	7									
YX	P	8	10	6	14	3	9								
	A	5	6	0	13	3	10								
	L	7	5	9	1	6	4								
	S	4	6	2	2	3	2								
BT	P	14	10	7	12	14	10	10							
	A	6	8	6	12	9	8	11							
	L	14	11	10	4	6	8	9							
	S	4	2	3	4	2	7	7							
BO	P	16	2	13	12	6	17	12	15						
	A	13	4	10	13	9	10	10	14						
	L	7	4	8	8	10	10	8	12						
	S	9	7	12	6	13	9	3	15						
YT	P	8	9	7	7	8	12	8	11	7					
	A	7	5	7	7	13	9	13	11	13					
	L	6	5	3	2	6	4	3	9	8					
	S	2	1	1	2	1	6	1	9	4					
RH	P	11	8	4	12	9	11	8	9	7	9				
	A	5	10	5	6	20	11	9	9	13	10				
	L	2	10	4	2	8	7	9	2	4	5				
	S	4	1	6	2	5	1	1	5	2	4				
BX	P	6	7	7	7	8	3	6	3	5	7	9			
	A	6	6	4	5	3	6	15	10	5	15	7			
	L	2	8	1	3	1	3	7	3	5	4	3			
	S	4	9	1	3	3	4	7	2	6	1	4			
YO	P	11	9	6	6	4	15	9	6	9	5	4	10		
	A	6	5	7	10	10	6	10	10	8	8	6	11		
	L	7	2	4	6	4	5	5	2	8	3	4	5		
	S	2	3	2	2	4	4	2	2	2	4	1	4		
YD	P	11	9	14	7	7	8	7	5	11	7	6	2	3	
	A	15	9	11	6	7	11	8	10	14	8	5	2	7	
	L	11	4	2	2	4	7	7	5	3	7	7	6	5	
	S	2	7	7	3	1	1	1	1	4	1	4	3	1	

* P = Evening rest in shelter; A = morning rest in shelter; L = Lettuce-eating in outside yard at noon; S = Sunning pattern outside in forenoon.

Note, for example, that RT contacted RX 22, 16, 7, and 13 times respectively in the 4 rest patterns mentioned above. (P, A, L, S).

TABLE 3.

abulation of Contacts and Units, both Random and "Social," of the 14 Giant Tortoises.

	RT	R=	BO	RO	RX	Y=	RD	BT	YD	YT	RH	YX	BX	YO
1*	169	162	227	205	243	248	235	242	218	245	252	266	236	257
2†	326	273	228	202	195	183	171	166	98	88	78	78	41	37
3‡	0.51	0.59	0.99	1.01	1.24	1.35	1.37	1.45	2.22	2.78	3.23	3.40	5.75	6.94
4§	29	32	35	37	39	38	40	39	44	44	46	45	49	49
5‖	22	20	17	14	13	14	12	13	8	7	6	6	3	3
6¶	16	12	12	9	10	6	8	6	3	3	2	4	2	1
7**	8	4	2	2	6	3	2	0	0	0	0	0	0	0

* Total number of random contacts (less than 11 in any single resting pattern).
† Total number of "social" contacts (more than 10 in any single resting pattern).
‡ Quotient (random contacts divided by "social" contacts).
§ Number of random units (a random unit comprises 10 or less contacts).
‖ Number of "social" units (a "social" unit comprises 11 or more contacts).
¶ Number of "social" units of 13 or more contacts each.
** Number of "social" units of 16 or more contacts each.

rom a "social" attraction that one indiidual had for another or a mutual attracion between two tortoises.

It seems evident that 22 contacts out of a ossible 28 (see Table 2, RT-RO, A; or RTX, P) is above the random level. In fact, here is reason to believe that the minimum umber of contacts above the random level s 11 (see Table 3). Hence, the term "social nit" is applied to 11 or more contacts reorded for any two individuals in any of he four rest patterns, as for example, R=-T: P 14, A 17, L 11, S 17 (Table 2). The otal "social score" of any individual is obained by multiplying the number of social nits by the number of contacts in each unit row 2, Table 3).

The random score for each tortoise is ecured by multiplying the number of ranom units (comprising less than 11 contacts between two specific tortoises) by the numer of contacts in each random unit (row 1, Table 3). If the total number of random contacts per individual is divided by the total social score, a quotient is derived for each nimal in the group which is a measure of its sociability when compared with that of others in the group (row 3, Table 3).

In row 4, Table 3, is given the number of random units tallied by each individual, while row 5 shows the social units recorded for each. Rows 6 and 7 give the number of social units of 13 or more contacts and 16 or more contacts each, respectively, as recorded for each member of the herd.

It will be noted in Table 3 that a break appears between BT and YD in the figures of rows 2, 3, 4, 5, 6 and 7; that is, between the eight larger turtles and the six smaller ones. Before examining individual performances, a comparison should be made between these two groups.

For example, the number of random contacts (row 1) of the larger specimens averaged 12.6% fewer than those of the smaller ones. The average number of random units was 36 for the larger and 46 for the smaller tortoises (Table 3), while the average number of contacts per random unit for the larger ones was 5.98, compared with 5.32 for the smaller group.

The number of "social" contacts (row 2) of the larger animals averaged 67.9% more than those of the smaller, while the average number of contacts per social unit for the larger ones was 13.78 compared with 12.80 for the smaller. The total of random contacts of the 8 big ones when divided by their total of social contacts yields a quotient of 1.06, compared with 4.05 for the 6 smaller turtles (row 3). The average number of social units among the larger animals was 15.7 compared with 5.5 for the smaller ones (row 5).

A comparison of the number of social units comprising 13 or more contacts each, shows that the former group averaged 9.87, the smaller group 2.5 (row 6). The larger group tallied an average of 3.37 social units of 16 or more contacts each, compared with none for the smaller group.

Additional evidence bearing upon the assumption that 11 contacts in each of the four rest patterns is above random assortment between two individuals, is noted by comparing the performances of RT and R=, and YD and YT, which were the most "sociable" in their respective groups, with the remaining six and four animals of these two groups, respectively. This is especially notable in comparing the number of 11-, 10-, and 9-contact units of these animals. For example, the four most "sociable" tortoises mentioned above averaged 3.75 of the 11-contact units each while the others averaged 3.3 units and 1.75 units, respectively. The average number of 10-contact units tallied by the four most "sociable" specimens was 3/4 unit and the combined average of the remaining 10 was four units. The average number of 9-contact units of the former was 2.75 while that of the latter was 4.7 units.

Table 4 analyzes the intra- and interspecies (or subspecies) contacts between giant tortoises. None of the contacts referred to as random or social were of the mounting type characteristic of mating. Only the behavior of the eight largest specimens is given in Table 4, since their activities were most

TABLE 4.

Number of Social Contacts and Social Units* of Each of the Eight Largest Tortoises in Their Respective Intra- and Inter-subspecific Social Relations (Non-sexual) with the Other 13 Members of the Herd.

Contacts with:	P†	A	L	S	Total
♂RT (vic.) vicina ♂♂	36^{2}	55^{3}	11	50^{3}	152
" ♀♀	32^{2}	26^{2}	—	—	58
Non " ♂♂	52^{4}	13	14	—	79
" " ♀♀	11	15	11	—	37
Totals	131	109	36	50	326^{22}
♂RO (vic.) vicina ♂♂	14	54^{3}	—	47^{3}	115
" ♀♀	11	11	—	15	37
Non " ♂♂	13	—	—	12	25
" " ♀♀	14	11	—	—	25
Totals	52	76	—	74	202^{14}
♂BT (van.) vicina ♂♂	26^{2}	12	25^{2}	—	63
" ♀♀	14	11	—	—	25
van. ♀ YT	11	11	—	—	22
van. ♂ BO	15	14	12	15	56
YO, RH, BX	—	—	—	—	—
♀ YD	—	—	—	—	—
Totals	66	48	37	15	166^{13}
♀RD (vic.) vicina ♂♂	33^{2}	47^{4}	—	31^{2}	111
" ♀♀	—	—	—	—	—
Non " ♂♂	14	20^{1}	—	13	47
" " —	—	13	—	—	13
Totals	47	80	—	44	171^{12}

Contacts	P	A	L	S	Total
♂R= (vic.) vicina ♂♂	28^{2}	47^{3}	11	47^{3}	133
" ♀♀	28^{2}	40^{3}	—	11	79
Non " ♂♂	36^{3}	25^{2}	—	—	61
" " ♀♀	—	—	—	—	—
Totals	92	117	11	58	273[illegible]
♂RX (vic.) vicina ♂♂	22^{1}	48^{3}	—	44^{3}	114
" ♀♀	19	24^{2}	—	27^{2}	70
Non " ♂♂	—	—	11	—	11
" " ♀♀	—	—	—	—	—
Totals	41	72	11	71	195[illegible]
♂BO (van.) vicina ♂♂	41^{3}	26^{2}	—	12	79
" ♀♀	29^{2}	—	—	13	42
van. ♀ YT	—	13	—	—	13
van. ♂ BT	15	14	12	15	56
YO, RH, BX	—	13	—	—	13
♀ YD	11	14	—	—	25
Totals	96	80	12	40	228[illegible]
♀Y= (vic.) vicina ♂♂	43^{3}	41^{3}	—	22^{2}	106
" ♀♀	—	—	—	—	—
Non " ♂♂	43^{3}	11	—	—	54
" " —	12	11	—	—	23
Totals	98	63	—	22	183[illegible]

* Number of social units indicated by superscript numerals.

† The four rest patterns are indicated thus: P = evening rest period; A = morning rest period; L = Lettuce-eating period; S = Sunning period.

pertinent to the present paper. The remaining six tortoises will be referred to indirectly, insofar as their actions relate to the eight large animals.

The males of the subspecies *vicina* differed markedly from the females of this subspecies. The intra-subspecific social contacts of the four males totalled 32 social units, averaging 16 contacts each. Each male averaged eight social units. The females, however, established no social units between themselves.

Sixteen social units (averaging 15.2 contacts each) were recorded between males and females of this subspecies, with an average of 2.6 social units per tortoise. Eleven social units were recorded between *vicina* and *vandenburghi* males. These units averaged 12.9 contacts each and two social units were the average per tortoise.

Three social units (average 11.3 contacts) were established between *vicina* males and the three small males, YO, RH and BX. Five social units (average 12.5 contacts) were noted between *vicina* males and female YD.

The social contacts between *vicina* females and non-*vicina* males totalled 10 social units (average 13.9 contacts). The social units between *vicina* females and non-*vicina* females totalled four (average 12.2 contacts).

It is interesting to note that the social contacts recorded between *vicina* males and *vicina* males, between *vicina* females and *vicina* males, and between *vicina* males and non-*vicina* males were almost the same, being 100, 90 and 101, respectively, in the P pattern. But in the A pattern, *vicina* males established twice as many social contacts (204) with *vicina* males as with *vicina* females (101) and five times as many as with non-*vicina* males (38) or with non-*vicina* females (40). Only two social units (average 11.0) in the L pattern were established between *vicina* males and *vicina* males; none with *vicina* females, two with non-*vicina* males (average 12.5), and one (11) with non-*vicina* females. In the S pattern the *vicina* males tallied 188 contacts between themselves or 12 social units (average 15.6). This was 3.5 times as many contacts as between *vicina* males and *vicina* females. No social units were recorded between *vicina* males and non-*vicina* males or non-*vicina* females in the S pattern.

Individual differences among tortoises were especially striking. For example, R= was rarely if ever observed in the mounting posture[4] with a female nor was he ever heard to "roar." The hoarse sound best described as "roaring" always accompanies copulatory activity. RT, on the other hand, could be heard bellowing almost every day and he mounted every female in the herd repeatedly.

[4] In the mounting posture, the concavity of the plastron of the male fits over the rounded posterior portion of the female's carapace.

TEXT-FIG. 3. Typical lettuce-eating (L) pattern. Reading from left to right, in front—BT, YT; behind, RD, BO, YX, YD, YO (shown turning away).

TEXT-FIG. 4. Typical mid-morning sunning (S) pattern. Reading from left to right, in front: R=, YO, RD, BO; behind, RX, RT. RO.

during the summer. Despite these differences, R= tallied six social units (average 13.1) with 79 contacts with *vicina* females, while RT tallied only four social units (average 14.5) and 58 contacts. RO also exhibited considerable sexual interest in females, yet tallied only three social units (average 12.3) and 37 contacts with *vicina* females. RX, like R=, displayed little sexual interest yet he is recorded with five social units (average 14.0) and 70 contacts.

RT and R= displayed almost equal companionship (the "Kumpan" of Lorenz, 1935, 1950) toward BT and BO; each established two social units with each of the latter. RT averaged 16.2, R= 12.2 contacts per unit. RO seemed to ignore BT but made two social units (average 12.0) with BO. RX ignored both except to eat lettuce (L pattern) with BT 11 times. Both RO and RX seemed oblivious of RH, BX and YO, but RT made 11 contacts each with RH and YO; R= contacted RH 12 times but failed to contact BX or YO "socially."

It is notable that the highest number of contacts per social unit among the *vicina* males was scored between themselves (16.09); the next highest with *vicina* females (13.72); followed by 12.22 with non-*vicina* males; and lastly 12.4 with non-*vicina* females, but only by RO and RT; neither RX or R= were recorded in contact with non-*vicina* females (YD or YT).

This last observation might indicate a relationship between sexual companionship and the companionship as exhibited by the P, A, L or S patterns. RT established three social units and RO two with YD, averaging 12.4 contacts each. These two males also displayed an intense sexual interest in YD. Neither male contacted YT "socially."

It is interesting that BO contacted YD 11 times in the P, and 14 in the A, pattern; BO also contacted YD sexually. BT failed to contact YD either "socially" or sexually. Both these males showed some interest in YT. BT contacted her 11 times in both P and

A patterns while BO made contact with her 13 times in the A pattern.

With the *vicina* females, BT contacted RD 14 times in the P, and YX 11 times in the A, pattern. BO made contact with RD 13 times in the S, Y= 17 times in the P, and YX 12 times in the P pattern (Tables 2 and 4).

With RH, the saddle-back tortoise, BO made contact 13 times in the A pattern. BT ignored RH and both *vandenburghi* males made only random contacts with the males BX and YO.

During the winter months, group A (comprising RT, R=, BO, RO, RX, Y=, RD and BT) is housed in the usual summer quarters, while group B (comprising YD, YT, RH, YX, BX and YO) occupies an adjoining inside corral. A number of apparently unrelated observations fit into a pattern when the separation of the two groups in winter is considered.

For example, RD and Y= contacted the four males, RT, RO, RX and R= (all of group A) a total of 217 contacts in eight social units each (average 13.5 contacts). On the other hand, YT (in group B) contacted BT and BO (both in group A) a total of only 35 times for three social units (average 11.6 contacts). Of a total of seven social units tallied for YT, only two were with individuals in group B, namely, BX (15 times) and YX (13 times).

RH made only random contacts with other members of group B, but with members of group A, RH established 78 contacts for six social units. BX, the other saddle-back, had different social inclinations. The three social units recorded for BX were all in the A pattern, and all were with individuals from group B, fifteen times each with both YT and YX and 11 with YO. This becomes more significant when it is noted (Text-figure 2) that all four of these animals were among the last to leave the barn in the morning or had to be urged to leave by the keeper.

For YD, 98 contacts were recorded for eight social units (average 12.2 contacts), of which none were with fellow members of group B. Even though this female failed to leave the barn promptly, her contacts with others of group B in the A pattern were only at random.

In general, it might be mentioned that the anticipated sociability within group B failed to materialize. The fact that the smaller specimens had been separated from the larger ones for about six months seemed rather to heighten the interest which members of each group had for the other, with the exception of male BX.

Discussion.

The migratory instinct might well have been the psychological factor around which the social pattern of the Galapagos tortoise developed. The ebb and flow of the wet and dry seasons made necessary the seasonal movements of the animals. The almost impenetrable underbrush and rocky landscape encouraged the migrants to frequent specific routes which, with the passage of the centuries, became deeply worn trails which permitted only one-way traffic.

It is assumed that, in order that the travellers might move without interruption some form of hierarchy developed with a leader who initiated movements and set the pace along the trail, and with a numerical order of sequence imposed upon the rest of the herd, so that each member would stay in line. An analysis of the behavior of the captive herd of tortoises revealed the presence of a hierarchy, but this was not surprising since these tortoises behaved, in some respects, similar to herds of mammals or flocks of birds in which it is well known that hierarchies occur.

It has been shown that environmental factors have been highly influential in shaping particular behavioral patterns. For example the diet of seaweed restricts the dispersal of the Galapagos Sea Iguana, *Amblyrhynchus cristatus*, to the rocky beaches where the feeding grounds are the flats between high and low tide. As a consequence the lizards swarm along the beaches, with the females and juveniles crowded behind an imaginary barrier 30 feet above high tide-mark while the big males dwell, each in his own small plot of beach, between the females and the water. Trespassing across the boundaries of these tiny territories results in fighting to reestablish territorial ownership (Schmidt, 1935).

Corn and bean seedlings and the leaves and blossoms of fruit trees attract the Mexican Iguana, *Ctenosaura pectinata*, to the vicinity of villages where it finds refuge in the loose-rock walls surrounding the gardens. Along the stone barriers the big lizards set up individual territories. The dominating male of the colony usurps the highest vantage point and the right to "patrol" the enclosing garden wall daily; at "patrol" time the other members of the colony retreat beneath the rocks, reappearing after the dominant male has passed by. At distances removed from human habitations the iguanas are usually widely scattered, with one male patrolling a territory perhaps 100 times as large as that possessed by an individual in a colony near a village (Evans, 1951).

The crowding which often occurs with the Mexican fence lizard is due to the paucity of lookout stations, hence scattered ruins are the sites for colony formation and its accompanying hierarchy (Evans, 1946). Colony formation sometimes occurs in the western fence lizard also (Fitch, 1940), although in both species individual territories occur where the competitive pressure is less.

Cagle (1944) has shown that the aquatic turtles, *Pseudemys scripta* and *Chrysemys picta*, occupy individual territories, but because good sunning logs are scarce, territorial claims are relaxed when it is time to leave the water and rest in the sunshine.

hen as many individuals as possible crowd pon such spots for relaxation.

The relative sparsity of the Anolis lizard pulation of Cuba enables each male to njoy a separate territory (Evans, 1938), hile in Bimini, the Anolis population is enser, making it necessary for two or more ales to occupy the same tree. When this ccurs, the largest male dominates the others the tree and a simple hierarchy is established (Oliver, 1948). When such crowding ccurs in a cage, a straight line hierarchy an be created involving as many as 19 males Evans, 1936).

SUMMARY.

Exactly how sociability (an endogenous rge on the part of one member of a herd be with or near to another) relates to ocial rank in Galapagos tortoises is not ear, but the eight largest specimens (group) in the New York Zoological Park were ore sociable than the six smaller ones group B), and if the entrance and exit rder, to and from the shelter, are considered, then the former were also higher social rank or hierarchy.

Sociability was tested in several ways. A istinction was made between random and ocial contacts. Group A established 67.9% ore social contacts and 12.6% fewer random contacts than group B. The greatest egree of sociability was recorded among the rge males of the subspecies *vicina*. These ales were successively less sociable toward *icina* females, non-*vicina* males, non-*vicina* emales. The *vicina* females were surprisngly asocial toward each other but were lightly more social toward females of other ubspecies. They were most sociable toward ales.

When the ratio of random contacts divided y social contacts was taken for groups A nd B, the figures were 1.06 for A and 4.05 or B.

The two *vicina* males that evinced the east sexual interest were most sociable oward *vicina* females and least sociable oward non-*vicina* females. In contrast, the wo most active *vicina* males, sexually speakng, were least sociable toward *vicina* females nd most sociable toward non-*vicina* females.

None of the social or random contacts ecorded in this report were of the mounting ype associated with sexual intercourse.

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13.

A New Genus and Species of Lithosiinae (Moths) from Rancho Grande, North-central Venezuela.[1]

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(Text-figure 1).

(This is one of a series of papers resulting from the 45th and 46th Expeditions of the Department of Tropical Research of the New York Zoological Society made during 1945 and 1946 under the direction of Dr. William Beebe with headquarters at Rancho Grande in the National Park of Aragua, Venezuela. The expeditions were made possible through the generous cooperation of the National Government of Venezuela and of the Creole Petroleum Corporation.)

Pseudomacroptila, new genus.

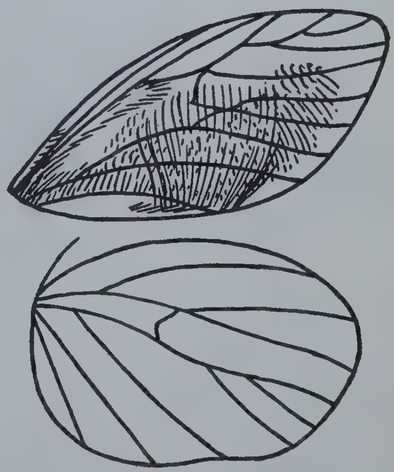
Text-figure 1.

Proboscis developed; palpi when upturned not reaching the vertex of head; first segment of palpi with fan-shaped ventral tuft and last segment porrect with a small terminal tuft of hairs. Each segment of the antennae with a stiff hair on each side; those on the outside of the segments separated by a row of fine short hairs. Legs normal for this group of genera. Abdomen and thorax with long hair. The last three segments of abdomen with lateral tufts. Last segment with a ventral-terminal tuft in addition to the lateral tufts.

Forewing moderately long and narrow. Vein R_1 from cell. Veins R_{2-5} stalked together; R_2 separating first, R_5 next and R_3 and R_4 long stalked. Vein M_1 free from tip of radial stem and M_2 and M_3 short-stalked. Vein Cu_1 from near end of cell and Cu_2 from approximately the first third of cell.

Hindwing with Sc from just before middle of cell, R_s and M_1 short-stalked, M_2, M_3 and Cu_1 long-stalked and Cu_2 from first third of cell.

Closely related to *Macroptila*, from which it differs by M_2, M_3 and Cu_1 of the hindwing being stalked and Cu_2 in both fore and hindwings arising from much nearer the base of the cell. It differs from the genotype, *M. crinada* Dognin, by R_2 of the forewing being stalked with R_{3-5}. It is most closely related to Hampson's section II[2]. The radial branches of the forewing are similar, the sex scaling quite alike (ibid; fig. 111; *M. laniata*) and



TEXT-FIG. 1. Fore and hindwings of *Pseudomacroptila argentea*, showing venation and sex scale pattern. (Drawing by Lloyd Sandford).

the hindwings lack a patch of androconia. The genus *Neagylla* has M_2, M_3 and Cu_1 forked in the hindwing, but the forewing is quite different since R_2 and R_3 are forked together and R_4 and R_5 separate nearer the apex of the wing.

Genotype: *Pseudomacroptila argentea*, new species, described below.

Pseudomacroptila argentea, new species.

Length of forewing of male 19 mm.

Outer margin of hindwing approximately twice as long as outer margin of forewing.

Front of head fuscous, antennae Light Ochraceous Buff. The second and third joints of palpi Tawny, first joint Antimony Yellow with a ventral series of hairs forming a fan which is concolorous with the ventrum of the thorax and coxa and dorso-proximal part of the prothoracic femur. Top of head and dorsum of thorax silver gray. The patagia and caudal edge of the last thoracic segment with long hairs. Dorsum of abdomen silvery gray but with a tinge of Light Ochraceous-Buff; ventrum Warm Buff.

[1] Contribution No. 905, Department of Tropical Research, New York Zoological Society.

[2] Cat. Lep. Phal. B. M., Vol. II, p. 191 (1900).

Forewings silvery white with a changeable quality like that of watered silk. Costal edge of forewing to near the apex Antimony Yellow. The area between the discal cell and inner margin appears in various lights darker as if tinged with buff. This is probably explained by the crinkling of the wing caused by the peculiar scent scales on the underside coupled with the fact that the coloring of the scales on the underside tend to ride through the wing membrane. Underside of forewing Warm Buff. Along the inner margin of the radial stem are long scales which become progressively larger as they approach the cell end. The larger scales are also narrowly spatulate. A line of shorter spatulate scales caudal of these on a remnant of the medial stem. In the lower part of the cell and from half way out the cell to half way between the cell end and the outer margin of the wing is a wide line of broadly spatulate scales which, beyond the cell, form a patch extending as far cephalad as vein M_1. Another narrower line of similar scales is situated on 2dA and run into the aforementioned patch around the cell end. Another very long and narrowly spatulate patch of scales below 2dA and near the margin of the wing. Between this last group of scales and the inner margin near the anal angle a short ridge of appresse scales.

Hindwing very large and broad as in *Macroptila crinada, laniata* and *fuscilianiata* Silvery white but the area cephalad of Cu tinged with dark gray. This color apparentl rides through from the underside of th wing where the same area is a slate gra with the costa Antimony Yellow.

The stalked condition of M_2, M_3 and Cu should distinguish this species from its described allies.

Material. A total of five male specimen taken as follows: Rancho Grande, nea Maracay, north-central Venezuela, April 30 holotype (Cat. No. 45482); June 28, paratype (Cat. No. 45483); July 5, paratyp (Cat. No. 45484a, slide of wings showin venation; 45484b, slide of wings showing se scales; 45484c, male genitalia; 45484d, hea and thorax); June 22, paratype (Cat. No 461232); June 22, paratype (Cat. No. 46644).

Paratype Cat. No. 46644 was taken flyin in the daytime, migrating through Portachuelo Pass. Four other specimens were see but not collected. The remainder of the type were collected at lights.

The holotype is deposited in the America Museum of Natural History, New York.

14.

Western Atlantic Tonguefishes with Descriptions of Six New Species.

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(Plates I-III).

The main object of the investigation here recorded, was to determine the species of *Symphurus* inhabiting the east coast of the United States, particularly the Gulf coast, and to elaborate the specific characters by which they are distinguishable. However, in order to properly understand, define and distinguish those species, it was found necessary to study all the species from the western Atlantic, including the West Indies.

The specimens forming the basis of this account are those in the U. S. National Museum, the Museum of Comparative Zoology and the Bingham Oceanographic Collection. Also, a valuable collection made by the U. S. Fish and Wildlife Service research boat *Pelican* which obtained specimens of four of the new species here described, including a good sample of *civitatum* from the coast of Louisiana.

All the available specimens of the western Atlantic only were studied in detail. For comparative purposes, I also examined in detail, in the National Museum, one specimen each of the following species from the American Pacific coast, namely, *fasciolaris, atramentatus, leei, sechurae, paitensis, atricauda* and *elongatus*, type specimens of the five species named first. All these specimens represent species which are different from those in the western Atlantic. As the intraspecific variability of the Pacific species was not determined, their relationship to one another and to the Atlantic species is not discussed in this paper.

One species, *Symphurus trewavasae* Chabanaud (*Bull. Mus. Paris,* (2)20:508, 1948), from Brazil, is not included, as none of the specimens examined, judged by their characters and locality of capture, coincide with Chabanaud's account. According to the figures given in the original account, *trewavasae* about agrees with *plagiusa* in the number of caudal rays and scales and proportional measurements. In comparing his species with *plagusia* and *plagiusa,* Chabanaud calls special attention to its supposedly large eye. However, in 5 specimens of *plagiusa* measured, the eye varies from 11 to 15 per cent. of the head. This range includes that of *trewavasae* given in its account. The numbers of dorsal and anal rays of *trewavasae* average a little higher than in *plagiusa,* but the two species widely overlap in these counts. The specimens on which *trewavasae* is based were collected in deeper water than that in which *plagiusa* lives on the coast of the United States. These two species should be directly compared in greater detail.

The other western Atlantic species described by Chabanaud in the same paper, *S. sumptuosus,* is apparently based on a specimen of *diomedianus,* and that name is placed below in its synonymy.

Symphurus Rafinesque.

Symphurus Rafinesque, Indice D'Ittiologia Siciliana, p. 52, 1810 (genotype *Symphurus nigrescens* Rafinesque by subsequent designation)—Jordan & Goss, Rep. U. S. Comm. Fish. 1886:321, 1889 (*Symphurus nigrescens* Rafinesque designated as genotype).

Sinistral, strongly compressed; symmetrically shaped; greatest depth in anterior half of length, the depth nearly uniform for a considerable distance, thence tapering both ways; the anterior taper moderate; posterior taper beginning at about end of anterior two-thirds of standard length, varying a little both ways, except in *jenynsi* at about the middle, the depth decreasing rapidly to caudal base. Eyes small, slightly smaller than short snout; the two eyes separated by a very narrow interorbital space in small specimens, touching each other or very nearly so in the larger specimens; anterior margin of upper eye slightly in advance of that of lower, infrequently both about aligned on same vertical. Snout short and very blunt, the anterior profile forming a nearly continuous broad curve. Mouth very small, its posterior angle under anterior margin of lower pupil, varying slightly both ways, except slightly more backward in *civitatum* and *plagusia;* asymmetrical, moderately curved on eyed side, notably curved on blind side. Anterior nostril on eyed side a well developed tubule, placed at some distance in front of lower eye, the tubule short on blind side; posterior nostril with a raised edge, placed directly in front of and between the eyes. Dentition chiefly developed on blind side, the teeth rather small, subequal or the outer teeth moderately larger, in bands; band in upper jaw of nearly

uniform and moderate width; band in lower jaw shorter and wider, shaped somewhat like the segment of a circle or moderately crescentic with the straight or slightly curved margin entad and the well curved margin ectad; dentition on eyed side very moderately or poorly developed, the teeth small, few or moderate in number, eyed side of upper jaw with a narrow band of teeth at symphysis in 2-3 irregular rows, tapering backward to one row, or one row throughout, or a small group of a few teeth near symphysis; eyed side of lower jaw with one row, or with very few teeth, or altogether toothless, depending on the species and intraspecific individual variability. Opercle separated by a posterior emargination into two lobes, the upper lobe smaller. Branchiostegal membranes united, their point of union at base of ventral fin. Isthmus free. Pseudobranchiae very moderate. No slit behind fourth gill arch. Gill rakers nearly obsolete, indicated as slight, uneven, variable protuberances on gill arch (not examined in all species). Body and head with ctenoid scales, those on anterior part of head becoming more or less embedded; caudal scaled at its base, the scales continued backward in rows between the rays for some distance, scaleless distally; dorsal and anal with short rows of small scales along the proximal part of the rays. Lateral line absent. Dorsal origin over eye; dorsal and anal continuous with caudal. Pelvic fin unpaired, placed at isthmus, normally having 4 rays (the rays counted in 364 specimens representing all species, only 3 variants, one each in *diomedianus, plagiusa* and *jenynsi*, having 3 rays). Pectoral absent. All rays segmented and unbranched.

Most characters in the preceding description of the genus are nearly common to the several species examined, and are not repeated under the species descriptions. Also, the western Atlantic species of *Symphurus* are unusually uniform in their structure, and not many characters are available for the purpose of distinguishing the separate species. For these two reasons, the species descriptions given below are very brief.

The number of rays in the caudal, dorsal and anal fins and that of the scales are of primary importance in the identification of the species. While the intraspecific variability of these counts or the spread of their frequency distributions is moderate in comparison with other flatfishes, it is yet rather extensive, and the best way of applying these characters in practice is by reference to tables showing their frequency distributions. As far as the available material permitted, such data have been determined and are presented in Tables 1-6.

The dentition on the eyed side is of some specific value as discussed below.

Color marks are of value in distinguishing some of the species. A black spot on the opercle of *plagiusa,* and spots on the dorsal and anal fins of *diomedianus*, are of limited value, as a majority but not all specimens, in both species, have these marks developed. A well marked spot on the caudal is present in the specimens examined of *urospilus* and *pterospilotus,* the latter also having spots on the dorsal and anal. Wide cross bands on the body often constitute a prominent feature of specimens of *Symphurus*. However, in three species, *plagiusa, civitatum* and *plagusia,* of which fair or good samples were examined, including many recently preserved specimens, this color pattern depends on individual variation, although the relative frequency of occurrence of banded individuals appears to differ also with the species. Within the range of every one of the three species the bands are well marked, or absent altogether, or present in various incomplete stages of development.

Proportional measurements, on the whole, are also rather uniform and are of only limited value in separating the species. Five measurements have been determined on a rather small number of specimens and are given under the accounts of the species as follows, named in order of their taxonomic importance: depth, caudal, head, preanal and postanal. Two species, *marginatus* and *nebulosus,* are markedly slender. The depth might also prove to be of value in distinguishing *pelicanus, piger* and *pusillus* from one another and from their close relatives, on examination of adequate samples of those three species. The caudal is notably short in *jenynsi* and *tessellata* and rather long in *pelicanus*. The other measurements do not differ much with the species, although a determination of adequate samples will likely show average differences, that is, divergent frequency distributions of various degrees of intergradation.

Two terms here used in stating proportional measurements, not commonly used in descriptive ichthyology, have the following meaning: preanal and postanal, the distance from the anal origin to the point of contact of a vertical tangent with the anterior curvature of the head, and the caudal base, respectively. The head was measured on the eyed side between the above point of contact and that of the upper lobe of the opercle. All proportional measurements are expressed as a percentage of the standard length. Under the accounts of some species where figures for proportional measurements are segregated by two size groups, those for the smaller specimens are given in parenthesis.

Three of the characters here used to distinguish the species, the numbers of caudal rays and scales, and the dentition on the eyed side, need to be discussed briefly.

Caudal fin ray count. The number of rays in the caudal fin differs with, and is of much importance in the classification of, the species of *Symphurus*. Every species of which good and fair samples were examined has a normal or decidedly predominating count. For instance, the normal count in *plagiusa* is 10, while in *plagusia* and *civitatum* it is 12. As the caudal is continuous with the

TABLE 1.

requency Distribution of the Number of audal Rays in Western Atlantic Species of *Symphurus*.

Species	Distribution					
	9	10	11	12	13	14
inor		15	1			
arvus		8	1			
elicanus				3		
rospilus			2			
terospilotus			1			
iomedianus		17	1			
lagiusa	3	334	8			
iger				5		
usillus				3		
arginatus				4		
ivitatum			2	36		
lagusia			1	23	1	
essellata			2	31	1	
enynsi	2	19				
ebulosus						3

rsal and anal fins, some practice is re-uired in order to distinguish the caudal rays rom the last ray of the other two fins. The audal rays have their bases on a nearly traight transverse line, sometimes some-hat irregularly curved, and are closely pproximated. The last dorsal or anal ray s more widely spaced from its adjacent audal ray and its base is placed slightly nore forward. After a little practice, the audal rays may be distinguished by these light peculiarities of structure, in nearly very fish, with very few somewhat doubtful ndividual specimens. The outermost caudal ay, both above and below, may be further istinguished in most specimens by another light peculiarity of structure. Its base is omewhat broader than that of the other audal rays and a little above its proximal nd it has a slight burr-like outward pro-ection. This is fairly evident, except in the mall specimens, and it is somewhat better marked in some species than others.

Some of the caudal rays are occasionally rregular in structure, such irregularities eing of three kinds, as follows: (1) A ray s sometimes incomplete, only a proximal portion of variable length being developed, sometimes as a short stump. (2) Only a small basal ossicle is present while the rest of the ray is undeveloped. In such instances the space between the two adjacent fully devel-oped rays is usually somewhat greater than that between the other rays. It seems evident that in such variants a potential ray failed to develop. There is no sharp line of division between the preceding two categories, as these irregular rays occur in all degrees of imperfect development, from being repre-sented by a mere, very small basal ossicle, to one in which only a moderate distal part remains undeveloped. (3) Two adjacent rays at a variable distance above their bases merge and become a single ray distally.

For the purpose of this statistical study and in Table 1, the partly developed ray, or the undeveloped ray represented by the basal ossicle only, were included in the count, and the two merged rays were counted sepa-rately. Such variants are not numerous and their numbers are stated under the accounts of the separate species. In *plagiusa* a total of 25 such variants was found in 345 speci-mens examined, or about 7 per cent. In this species the irregularity occurring most often falls in the above category (2) and the least often in category (3). In *diomedianus* 3 such variants out of 18 specimens examined fall partly or wholly in category (3). In *civita-tum* 2 irregular variants were found among 38 specimens examined, and in *plagusia*, sensu stricto, 3 variants among 25 speci-mens. Four of the latter 5 variants belong to category (2) and one falls in category (1).

Except for the preceding moderate imper-fections, the caudal fin is fairly regular. Of the many specimens examined, more than 600, the caudal count in only 3 fish could not be definitely determined. Two specimens were obviously injured in life and irregu-larly regenerated. The third is evidently an abnormal specimen and is described under its species, *minor*.

Scale count. The scale count here given refers to the number of oblique rows from the upper angle of the opercle to the caudal base. The scales run in fairly regular rows and when the scalation is complete a near accurate count is possible. However, in very many of the specimens examined the scales are missing on areas of variable extent. In such cases the count includes in part the rows of scale pockets which are sometimes indistinct. Consequently, the scale counts here given are only roughly approximate, but even so this character is of considerable value in separating the species. In Table 4 the counts of individual specimens are grouped by intervals of 3, the class headings representing their mid numbers.

Dentition. The dentition on the eyed side, especially that on the lower jaw, is of value in distinguishing some of the species. It is described under the accounts of the separate species and is also used in the key. This char-acter is not easy to apply in practice. The teeth are small, partly hidden by the gums and lips, and may be discerned properly only with a strong magnifier and after the pre-serving fluid has been thoroughly evapo-rated. Also, the mucous membrane lining the jaws is usually covered with papillae which in superficial appearance simulate

TABLE 2.

Frequency Distribution of the Number of Dorsal Rays in Western Atlantic Species of *Symphurus*, Totals for the Species and Subspecies.

Species	Distribution																																			
	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101		109	110	111	112	113	114
minor	5	3	6	3																																	
parvus							2		4		1	1	1																								
pelicanus									1	2																											
urospilus													1		1																						
pterospilotus																						1															
diomedianus																		1	3	6	3	4															
plagiusa														5	8	29	55	42	20	11	2																
piger														1	3		1																				
pusillus														1	1		1																				
marginatus																									1	1	2										
civitatum																3	2	5	14	10	3																
plagusia																			2	1	1	2	5	5	6	2	1										
tessellata																								1	5	9	8	7	2	2							
jenynsi																																4	7	1	4	3	1
nebulosus																																1	1			1	

TABLE 5.

Frequency Distribution of the Number of Anal Rays in Western Atlantic Species of *Symphurus*, Totals for the Species and Subspecies.

Species	Distribution																																			
	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85		92	93	94	95	96	97	98
minor	1	2	5	4	4	1																																
parvus									2	2	3	1	1																									
pelicanus								1			1	1																										
urospilus													1			1																						
pterospilotus																				1																		
diomedianus																		2	3	7	1	4	1															
plagiusa														3	16	27	50	40	22	12	1		1															
piger																	2	3																				
pusillus																1	1			1																		
marginatus																											2	1										
civitatum															1	2	1	8	12	10	3	1																
plagusia																	1				3	2	6	3	5	3	2											
tessellata																							1	1	2	11	10	5	3	1								
jenynsi																																1	1	7	5	3	3	
nebulosus																																		2				1

TABLE 4.

Frequency Distribution of the Number of Scales in Western Atlantic Species of *Symphurus*.

Species	Distribution																								
	55	58	61	64	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109	112	115	118	121	124	127
minor	2	1	6	1	1																				
parvus			3	4		1	1																		
pelicanus			1		1		1																		
urospilus							1	1																	
pterospilotus												1													
diomedianus											1	4	4	6	1										
plagiusa						1	22	72	89	28	3														
piger						2	4																		
pusillus									1	2															
marginatus													1	1											
civitatum						3	11	16	7																
plagusia							1	5	2	8	6	1	1												
tessellata									1	8	12	8	2												
jenynsi																	4	4	4	2	2	1			
nebulosus																								1	2

ery small teeth, and particular care must e exercised not to mistake them for teeth. Species living in deep water generally have he dentition on the eyed side better develped.

Vertical distribution. Judged by the fair umber of available depth records for the pecimens examined, it is evident that the pecies of *Symphurus* are markedly selecive in their vertical distribution. Some speies have the same vertical distribution, or early so, but in many instances they differ n this respect. Some species differ widely n their vertical distribution, and depth recrds become of value in separating them. Even where two given species overlap in heir vertical distribution, the extreme depth ecords are of value. Consequently, in colecting specimens of *Symphurus* it is of articular importance to record the depths t which they are taken.

Minor population differences. Some of the haracters that are used for distinguishing he species, also differ intraspecifically with he minor population. Such minor differences n the number of dorsal and anal rays are hown to a limited extent in Tables 5-6 for hree species and are also discussed under he accounts of those species.

KEY TO THE WESTERN ATLANTIC SPECIES OF *Symphurus*.

1a. Dorsal rays 72-83; anal rays 56-67; when dorsal and anal rays up to 84 and 68, respectively (in *parvus*), caudal without a definite spot. Scales 55-74. Teeth on eyed side of lower jaw extending over its greater part to nearly its entire length.

2a. Caudal rays usually 10, sometimes 11. Caudal 12-16.

3a. Dorsal rays 72-75. Anal rays 56-61. Scales 55-66 .... *minor* (p. 192).

3b. Dorsal rays 78-84. Anal rays 64-68. Scales 60-73 .... *parvus* (p. 192).

2b. Caudal rays 12. Dorsal rays 80-81. Anal rays 63-67. Scales 61-74. Caudal 17.5. *pelicanus* (p. 193).

1b. Dorsal rays 85-101; anal rays 69-85; when dorsal and anal rays down to 84 and 68, respectively (in *urospilus*), caudal with a well marked black spot. Scales 69-98.

4a. Caudal with a large well marked spot. Caudal rays perhaps normally 11 (same count in 3 available specimens of both species). Teeth on eyed side of lower jaw absent or only a few present.

5a. Dorsal rays 84-86. Anal rays 68-71. Scales 73-77. No definite spots on dorsal and anal .. *urospilus* (p. 193).

5b. Dorsal rays 93. Anal rays 75. Scales 88. Posterior part of dorsal and anal with definite spots *pterospilotus* (p. 194).

4b. Caudal without a well marked spot. Caudal rays normally 10 or 12 depending on the species, variants having 11 rays comparatively few, in 2-6 per cent. of the specimens in the samples examined.

6a. Caudal rays normally 10. Teeth on eyed side of lower jaw usually absent, sometimes a few present on side of jaw.

7a. Scales 86-98. Dorsal and anal with definite spots posteriorly, well marked in light colored or faded specimens, obscure or imperceptible in dark colored fish. No black spot on head. Offshore. Dorsal rays 89-93. Anal rays 73-78 *diomedianus* (p. 194).

7b. Scales 71-86. Dorsal and anal without well marked spots. Many specimens having a black spot on opercle. Inshore to moderately offshore. Dorsal rays 85-92. Anal rays 69-78 .... *plagiusa* (p. 195).

6b. Caudal rays normally 12.

8a. Teeth on eyed side of lower jaw extending over its anterior half or its greater part. Deep water species, available depth records ranging 40-324 fathoms.

9a. Dorsal rays 85-88. Anal rays 71-75.

10a. Scales 69-73. Depth 29.0-30.5 in specimens 50-86 mm. in standard length *piger* (p. 197).

10b. Scales 79-83. Depth 28.0-28.5 in specimens 53-59 mm. in standard length *pusillus* (p. 197).

9b. Dorsal rays 96-98. Anal rays 82-83. Scales 92-95. Notably slender, depth 21.0-22.5 in specimens 90-115 mm. in standard length *marginatus* (p. 198).

8b. Teeth on eyed side of lower jaw normally, or usually, absent, often a few teeth present on side of jaw in *plagusia*. Species living in shallow water or moderately offshore, greatest available depth record 18 fathoms.

11a. Dorsal rays 87-92. Anal rays 70-77. Scales 69-80. Coast of the United States *civitatum* (p. 198).

11b. Dorsal rays 90-98. Anal rays 76-82 (72 in one specimen out of 25). Scales 74-90. West Indies and Panama *plagusia plagusia* (p. 199).

11c. Dorsal rays 95-101. Anal rays 78-85. Scales 80-92. Brazil *plagusia tessellata* (p. 200).

1c. Dorsal rays 109-114. Anal rays 92-98.

12a. Caudal rays usually 10, sometimes 9. Scales 102-118. No teeth on eyed side of lower jaw
jenynsi (p. 200).

12b. Caudal rays 14. Scales 123-128. Teeth on eyed side of lower jaw present
nebulosus (p. 200).

Symphurus minor, new species.

Description. C 10 (11). D 72-75. A 56-61. Sc 55-66. Teeth on eyed side approximately extending over anterior half of upper jaw and anterior two-thirds of lower jaw. Measurements of 6 specimens 42-75 mm.: caudal 13.5-16.0, depth 28.5-30.5, head 22.5-23.0, preanal 28-31, postanal 73-78.

Rather faintly cross-banded, the bands diffuse, irregular, incomplete, often widely interrupted, in form of 2 short bars placed at dorsal and anal profile, on same vertical; one band at a moderate distance from caudal base often somewhat better developed than others; irregularly shaded with dusky and sometimes washed with whitish; fins rather light colored; no distinctive markings; color description based on only a few of the specimens examined, most specimens seemingly faded or turned dark by preservative.

Caudal rays. 14 and 1 specimens have fully developed 10 and 11 rays, respectively; one has 2 rays fused above their bases and 8 full rays or a total of 10. One specimen with a teratic caudal is described below.

Holotype. U.S.N.M. 131643; Albatross Station 2406; Lat. 28° 46′ N., Long. 84° 49′ W.; off St. George Island, Florida; 26 fathoms; March 15, 1885; 42 mm.

Paratypes. Two specimens obtained with the holotype (152734); off Cape San Blas, Florida (131590-91, Albatross Station 2374, 26 fathoms; 131593, Albatross Station 2372, 27 fathoms); off Savannah (155233, Pelican Station 195-9, 24 fathoms) and St. Catherines Island (155230, Pelican Station 196-2, 12 fathoms), Georgia; off Charleston, South Carolina (155231, Pelican Station 182-22, 11 fathoms; and 155232, Pelican Station 194-11, 17 fathoms); off Cape Lookout, North Carolina (134272, Albatross Station 2609, 22 fathoms); off Halifax, Nova Scotia (92614, Albatross Station 2505, 93 fathoms). Total paratypes 15, 26-78 mm., taken in 11-27 fathoms, except off Nova Scotia in 93 fathoms.

The specimens from Albatross Station 2374 might be the same as were included in the original account of *piger* as noted below under that species.

One specimen, 37 mm. (153098), taken off Palm Beach, Florida, in 40 fathoms, has the caudal with 12 rays distally, and one of these rays represents a distal fusion of two rays which arise separately at the basal part of the fin. According to the method of counting here adopted, it should be recorded as having 13 caudal rays. However, the caudal of th[is] specimen is obviously teratic. Some of th[e] rays are sinuous instead of being straigh[t]. What is more striking, their bases are no[t] in a clear-cut regular row, as they normall[y] should be, but they overlap one another an[d] are generally highly irregular. At one poin[t] what appear to be a few basal ossicles ar[e] irregularly aggregated in a group. It is ev[i]dent that this specimen is abnormal wit[h] respect to the development of the caudal, an[d] this count was omitted from Table 1. It ha[s] D 73, A 57 and Sc 60, agreeing with *mino[r]* in these counts which are included in Table[s] 2-4.

Comparison. This species differs from a[ll] other species here treated in its low dors[al] and anal counts. Its scale count also average[s] lowest, but this character intergrades widel[y] with *parvus* and *pelicanus*, and *minor* is als[o] nearest to those two species in the dorsa[l] and anal counts. It is closely related t[o] *parvus*, agreeing with it in normally havin[g] 10 caudal rays, while *pelicanus* normally ha[s] 12 caudal rays. Judged by the small sample[s] examined, its size averages smaller tha[n] *parvus*.

Symphurus parvus, new species.

Aphoristia pigra Goode & Bean (in part), *Bull. Mus. Comp. Zool.*, 12: 154, 1886 (specimens from Albatross Station 2318 here forming in part basis of *S. parvus*).

Aphoristia diomediana Goode & Bean (in part), Ocean. Ichthy., p. 460, 1895 (specimens from Blake Station XXV examined).

Description. C 10 (11). D 78-84. A 64-68. Sc 60-73. Teeth on eyed side very small; in upper jaw extending for half its anterior length or some distance farther backward; in lower jaw extending for its greater part or nearly its entire length. Measurements of 5 specimens 53-78 mm.; caudal 13.0-15.5, depth 27.0-31.5, head 22.5-24.5. Preanal 27-30, postanal 74-77.

Two recently preserved specimens 44-4[?] mm., rather irregularly shaded or diffusel[y] spotted all over without distinctive markings; other specimens examined apparentl[y] partly or wholly faded; the holotype, in addition to the faint shadings all over, with [a] faint suggestion of a cross band on posterio[r] part of body and a better marked transversely oblong spot at a moderate distanc[e] in front of caudal base; another specime[n] with an irregularly rounded, large brow[n] spot at dorsal profile, not far from cauda[l] base; fins light colored, irregularly fleck[ed] and shaded with dusky.

Caudal rays. 8 specimens have 10 and [1] has 11 rays, all fully developed.

Holotype. U.S.N.M. 84491; Albatross Station 2318; Lat. 24° 25′ 45″ N., Long. 81° 4[6′] W.; off Boca Chica, Florida; 45 fathoms; January 15, 1885; 73 mm.

Paratypes. 4 specimens 53-78 mm., fro[m] the same Albatross Station as the holotype as follows: 152733, one specimen originall[y]

same jar with holotype; 74330, originally labelled cotypes of *Aphoristia pigra*. Off Sombrero Light, Florida (153090, 50-60 fathoms, 63 mm.). Off Palm Beach, Florida (153088, 20-30 fathoms, 44 mm.; 153097, 0 fathoms, 48 mm.). Total paratypes 7, 4-78 mm., taken in approximately 20-60 fathoms.

The following two specimens evidently also belong to this species: Off Palm Beach, Florida (153087, 58 mm.). This specimen is injured and its fin ray counts are not accurately determinable. Blake Station XXV (47657, 66 mm., probably West Indies). The latter is apparently the specimen referred to by Goode & Bean in their 1895 account of *A. diomediana*. Its dorsal, anal and scale counts, included in Tables 2-4, fall at the extreme end on the right of the distribution of *parvus*.

Comparison. This species is structurally nearest *minor* and the differences between them are discussed under that species. It is also compared with *pelicanus* under the account of the latter.

Symphurus pelicanus, new species.

Aphoristia diomediana Goode & Bean (in part), Ocean. Ichth., p. 460, 1895 (specimen listed below from Albatross Station 2121-2122 evidently included in account cited).

Description. C 12. D 80-81. A 63-67. Sc 61-74. Teeth on eyed side very small, in lower jaw extending for nearly its entire length, in upper jaw ending at some distance before angle of mouth. Measurements of 3 specimens 60-71 mm.: caudal (in two specimens) 17.5, depth 27.5-28.5, head 22.0-23.5, preanal 26-30, postanal 75-78.

Body and fins light yellowish, irregularly and very lightly shaded, almost immaculate. Blind side of Trinidad specimen thickly sprinkled with very small dark points, these points more sparsely distributed and finer in the two Texas specimens; all three specimens with a large dark area directly behind head at ventral profile on both sides of fish, evidently the black peritoneum showing externally.

Caudal rays. Two specimens have 12 complete rays; 1 has 2 rays fused above their bases and 10 complete rays or a total of 12.

Holotype. U.S.N.M. 155234; Pelican Station 115-5; Lat. 26° 43′ N., Long. 96° 51′ W.; off Padre Island, Texas; 25 fathoms; February 4, 1939; 60 mm.

Paratypes. U.S.N.M. 155235; Pelican Station 116-4; Lat. 26° 34′ N., Long. 96° 32′ W.; off Padre Island, Texas; 45 fathoms; February 5, 1939; 70 mm. U.S.N.M. 74331; Albatross Stations 2121-2; Station 2121, Lat. 10° 37′ 40″ N., Long. 61° 42′ 40″ W., off Trinidad, B. W. I., 31 fathoms; Station 2122 is a short distance away and in 34 fathoms; one specimen 60.9 mm. in standard length, about 71 mm. in total length.

Comparison. This species nearly agrees with *parvus* in the number of dorsal and anal rays and scales. It differs in having 12 caudal rays. The two species also differ on the average in the caudal length and body depth, *pelicanus* having a longer caudal and slenderer body. There may be some minor color differences, but the small samples examined do not permit the evaluation of such probable differences. This species should also be compared with *piger*, the two agreeing in the number of caudal rays and the dentition on the eyed side. They differ in the number of dorsal and anal rays as shown in Tables 2-3. When adequate samples of *pelicanus* and *piger* become available, their frequency distributions in the number of those rays will likely be found to approach closely. This species differs from *piger* also in having a slenderer body and longer caudal.

This species is named after the U. S. Fish and Wildlife Service research boat *Pelican*, which brought together a very valuable collection of specimens from the southeast coast.

Symphurus urospilus, new species.

Description. C 11. D 84-86. A 68-71. Sc 73-77. Eyed side of large specimen with a very few teeth at symphysis of upper jaw, none on lower; in small specimen teeth in upper jaw more numerous and 2 teeth on side of lower jaw. Measurements of 2 specimens 146 and 42 mm.: caudal 11.5 (13.5), depth 34 (32), head 19 (23.5), preanal 24 (30), postanal 82 (76).

A large black spot on caudal, nearer distal margin than base of fin, surrounded by a hyaline area; brownish with transverse, broad, brown bands deeper than ground color, 3 crowded bands on head, 9 on body, the last 3 faint and more approximated than others (scales largely missing on posterior part of body and bands very faint). The above color description is from the large, fairly recently preserved specimen. The small specimen, long in preservative, has the cross bands faint, but the caudal spot is sharply marked and ocellated with white.

Caudal rays. Both specimens have 11 complete rays.

Holotype. U.S.N.M. 155225; Pelican Station 181-8; Lat. 32° 01′ N., Long. 80° 11′ 30″ W.; off Savannah, Georgia; 12 fathoms; February 3, 1940; 136 mm.

Paratype. U.S.N.M. 73262; Fish Hawk Station 7154; Lat. 29° 32′ N., Long. 83° 58′ 30″ W.; off Pepperfish Key, Florida; 10.5 fathoms; November 7, 1901; 42 mm.

Comparison. Considering that in all species except *pterospilotus*, 11 caudal rays occur only in variants, in most species in rather infrequent variants, it is highly probable that the 11 caudal rays in both available specimens will prove to be the normal number in this species. It differs from all other species, again excepting *pterospilotus*, in having a caudal spot. It is compared with *pteropilotus* under the account of that species. The number of dorsal and anal rays and scales in this species is rather low, being at the borderline between the first two groups of species separated in the key.

Symphurus pterospilotus, new species.

Description. C 11. D 93. A 75. Sc 88. Eyed side of upper jaw with a few teeth near symphysis; that of lower jaw with very short, slender papillae, without teeth. Measurements of a specimen 127 mm.: caudal 11.5, depth 30, head 19, preanal 27, postanal 81.

Dusky shaded with darker, faint traces of diffuse, irregular and incomplete cross bands; caudal and posterior part of dorsal and anal dark; dorsal with 4 somewhat unevenly spaced black spots; the first near beginning of its posterior third, the last near its junction with caudal; 4 similar spots on anal opposite to those of dorsal; an elongate black spot nearly centered on caudal.

Caudal rays. 11 complete rays in the single specimen examined.

Holotype. U.S.N.M. 87770; Isla de Flores, Uruguay; W. L. Schmitt.

Comparison. This species has the unique combination of 11 caudal rays, a spot on the caudal, and spots on the dorsal and anal fins. It agrees with *urospilus* in the number of caudal rays and its spot, but differs in the number of dorsal and anal rays and scales. Unlike *urospilus* it has spots on the dorsal and anal and it is not as deep bodied. It agrees with *diomedianus* in having spots on the dorsal and anal, but differs in having a well defined spot also on the caudal, and it is very highly probable that it differs further from *diomedianus* in the number of caudal rays.

Symphurus diomedianus (Goode & Bean).

Aphoristia diomediana Goode & Bean, *Proc. U. S. Nat. Mus.*, 8:589, 1886 (off Tortugas, Florida; 26 fathoms)—Goode & Bean (in part), Ocean. Ichthy., p. 460, pl. 90, fig. 378, 1895 (off Tortugas, Yucatan, Trinidad and Dominica; the specimen from Trinidad here referred to *pelicanus*, that from Dominica not examined).

Symphurus diomedianus Jordan & Evermann, *Bull. U. S. Nat. Mus.*, 47 (3): 2711, 1898 (after Goode & Bean).

Symphurus sumptuosus Chabanaud, *Bull. Museum Paris*, (2) 20:509, 1948 (Rio de Janeiro).

Description. C 10 (11). D 89-93. A 73-78. Sc 86-98. Teeth on eyed side absent or a few present at symphysis of upper jaw and on middle of lower jaw. Measurements of specimens 133-207 mm.: caudal 10.0-12.5, depth 28.5-31.0, head 18-20, preanal 23-26, postanal 78-83.

Almost uniformly brownish, or with faint traces of cross bands, or irregularly mottled or blotched with dark shades; posterior part of dorsal and anal variably dusky, sometimes nearly black, with 1-4 rounded irregularly spaced spots on each fin, not far from caudal, on about posterior fifth of standard length; these spots moderately or sharply marked, sometimes faint or hardly perceptible, especially in specimens with very dark fins.

Caudal rays. Three specimens out of 18 have the structure of the caudal irregular, in all three 2 of the rays being fused at a

TABLE 5.

Frequency Distribution of the Number of Dorsal Rays in Three Western Atlantic Species of *Symphurus*, Segregated by Minor Populations.

Species and Populations	Distribution													
	85	86	87	88	89	90	91	92	93	94	95	96	97	98
diomedianus														
United States and Yucatan					1	3	3	1	2					
Brazil							3	2	2					
plagiusa														
Long Island Sound to Cape Canaveral	3	2	18	29	18	13	8	1						
Key West to Tampa	2	4	8	10	7	1								
Apalachicola to Corpus Christi		1	2	15	17	6	3							
Cuba			1					1						
plagusia														
Cuba									1	2			1	1
Hispaniola							1			2	1	1		
Puerto Rico						2		1		1		1		
Panama									1		4	2	1	

variable distance above their bases to form a single ray distally, as follows. One variant has 1 ray incomplete, 2 rays fused and 7 complete rays or a total count of 10. Another variant has 2 rays fused and 8 complete rays. The third variant has 2 rays fused and 9 complete rays or a total count of 11. The other 15 specimens have 10 complete rays.

Specimens examined. From off the following localities: North Carolina (152029); Key West (107322, 129945) and Tortugas (37347, the type), Florida; Isle Derniere (154978, collected by the Pelican) and Atchafalaya Bay (154977, 154979; Pelican), Louisiana; Cabo Catoche, Yucatan (133935); Rio de Janeiro (M. C. Z. 889 and 4665) and Victoria (M. C. Z. 11377), Brazil. Total examined 18 specimens 68-207 mm. The largest specimen is from the coast of North Carolina.

Comparison. This species normally has 10 caudal rays like *plagiusa*, and differs from that species in the higher scale count. The numbers of dorsal and anal rays average considerably higher. The black spots on the dorsal and anal, when present, distinguish this species from *plagiusa* and all other species examined from the western Atlantic, except *pterospilotus*, but the spots are hardly perceptible in some specimens. The vertical distribution also separates it incompletely from *plagiusa*. Seven available depth records for *diomedianus* range from 17 to 50 fathoms, and one specimen was taken at 8 fathoms; while *plagiusa* is most common inshore and ranges only to 14 fathoms offshore. It is compared with *pterospilotus* under the account of that species.

Synonymy. According to Chabanaud's description, the type specimen of his *sumptuosus* agrees with *diomedianus* in the number of caudal, dorsal and anal rays and scales, in the presence of spots on the dorsal and anal and the absence of a spot on the caudal. That *diomedianus* does occur on the coast of Brazil is proved by the 7 specimens examined in the Museum of Comparative Zoology from that coast as listed above. It is, therefore, concluded that *sumptuosus* is a synonym of *diomedianus*.

Populations. The composite sample examined from Brazil averages a little higher dorsal and anal counts than that from the coasts of the United States and Yucatan, as shown in Tables 5-6.

Symphurus plagiusa (Linnaeus).

Pleuronectes plagiusa Linnaeus, Syst. Nat., ed. 12, p. 455, 1766 (no locality, received from Dr. Garden and probably came from Charleston)—Goode & Bean, *Proc. U. S. Nat. Mus.*, 8:196, 1886 (description of type, see below).

Plagusia fasciata De Kay, *Zool.*, New York, pt. 4, Fishes, p. 304, 1842 (South Carolina, based on an unpublished illustration by Holbrook).

Symphurus plagiusa Jordan & Goss, Rep. U. S. Comm. Fish. 1886:325, 1889 (Beaufort, Charleston, Pensacola and Key West) —Jordan & Evermann, *Bull. U. S. Nat. Mus.*,

TABLE 6.

Frequency Distribution of the Number of Anal Rays in Three Western Atlantic Species of *Symphurus*, Segregated by Minor Populations.

Species and Population	Distribution													
	69	70	71	72	73	74	75	76	77	78	79	80	81	82
diomedianus														
United States and Yucatan					1	3	6		1					
Brazil					1		1	1	3	1				
plagiusa														
Long Island Sound to Cape Canaveral	2	6	13	30	22	13	6							
Key West to Tampa	1	6	7	11	4	2	1							
Apalachicola to Corpus Christi		3	5	9	14	7	5	1						
Cuba			1							1				
plagusia														
Cuba									1	1		1	1	1
Hispaniola				1					1	1	1	1		
Puerto Rico								3		1		1		
Panama										3	2	1	2	

47 (3): 2710, 1898 (same localities as preceding).

Description. C (9) 10 (11). D 85-92. A 69-76 (78). Sc 71-86. Eyed side with teeth on anterior half of upper jaw or for a shorter distance; usually no teeth on eyed side of lower jaw, sometimes a very few teeth at its side. Measurements of 5 specimens 124-147 mm. and 6 specimens 54-77 mm.: caudal 11.0-11.5 (11.5-13.0), depth 29.5-31.5 (27-31), head 18.5-20.5 (21.0-22.5), preanal 24-26 (24-30), postanal 79-83 (77-81).

Color very variable; cross bands darker than ground color, present or absent, when present in various stages of development from almost solidly continuous to interrupted, incomplete or irregular in various degrees, or only faintly indicated; sometimes with few or many intensely dark, very small specks; a large black spot on opercle, centered on its upper lobe, present in the majority of the larger specimens, especially those recently preserved, usually faint or absent in the smaller specimens and often also in the larger; sometimes a smaller solid or interrupted black spot also on lower posterior part of head; dorsal, anal and caudal fins faintly or moderately dusky, usually with a darker pigment along the rays.

Caudal rays. Of 345 specimens of which the caudal was examined as recorded in Table 1, 25 specimens or 7.2 per cent. have an irregular or imperfect structure, as follows:

The 3 variants with 9 caudal rays have them fully developed, without irregularities in structure.

Among the 334 specimens recorded as having 10 rays, 22 have an imperfect structure, as follows: 9 have one of the 10 rays in the form of a very small basal ossicle; 2 have 2 such ossicles representing 2 rays; 1 has 3 ossicles and only 7 fully developed rays; 7 have 1 ray in various degrees of incompleteness, in some of them in the form of a very short stump; 2 have 2 of the rays fused at some distance above their bases; 1 specimen has 2 rays in the form of stumps, 2 rays fused above their base and 6 complete rays.

Among the 8 variants recorded in Table 1 as having 11 rays, 5 specimens have them fully developed, while 3 have 1 ray in the form of a basal fragment and 10 complete rays. These 8 variants are important from the practical standpoint of identification in distinguishing *plagiusa* from *civitatum*. Seven of these 8 variants are identified as being specimens of *plagiusa* on the following grounds: 5 have a black spot on the opercle which is a unique color mark of *plagiusa;* 2 which lack a definite opercular spot, were taken in shallow water situations where only *plagiusa* lives, one by seining the beach on Cat Island, Mississippi, the other by trawling in Barataria Bay, Louisiana. The eighth specimen, small and faded, was taken off Anclote Key, Florida, in 6¼ fathoms (133980). As it differs from normal specimens of *plagiusa* in having, in addition to 10 fully developed caudal rays, only an extra very small basal ossicle, the probabilities are that it is a variant of *plagiusa,* but this is not altogether certain. By an outside chance, it might possibly be a variant of *civitatum.*

Specimens examined. Long Island Sound (59056, 5 specimens 41-55 mm.). Chesapeake Bay (Cape Charles City, Cape Charles, Thimble Shoal, Ocean View; altogether 13 specimens 52-176 mm.). Many lots ranging from Cape Hatteras, North Carolina, to Key West, Florida, on the Atlantic coast and from Cape Sable, Florida, to Laguna Madre, Texas, on the Gulf coast. Also, 2 specimens from Cuba (37750, 107365). The largest specimens are 189 mm. (one from St. Augustine, Florida, B.O.C. 3708; another from "Florida Keys," M.C.Z. 11060).

This is the most common species of *Symphurus* on the Atlantic and Gulf coasts of the United States. Altogether 130 constituent samples comprising 347 specimens were examined. It is an inshore species and ranges offshore to a depth of 14 fathoms. Depth records are available for 32 of the lots. They were mostly taken in open water offshore in 2-14 fathoms. Many of the other lots, perhaps all of them, were taken by shore seining or by trawling in the inner shallow water bays and estuaries. The latter situations evidently constitute the center of abundance of *plagiusa* with respect to the vertical distribution of the species of *Symphurus,* and of all those examined no specimens of any other species were taken in such locations.

Comparison. This species is usually distinguishable by the combination of normally having 10 caudal rays, the presence of a black spot on the posterior part of the head in many specimens, its dorsal, anal and scale counts and its usual shallow water habitat. In the number of caudal rays it agrees with *diomedianus* and is further compared with it and with *civitatum* under the accounts of those species.

Nomenclature. Goode & Bean (cited above) present some measurements of Linnaeus' type specimen of *plagiusa* which, converted to percentages of the standard length, give depth 23 and head 17. These measurements do not apply to the common American species here treated, and this species seemingly should be designated *fasciata* De Kay. However, I hesitate to alter well established usage without confirmation of the measurements and further study of the questions involved. Therefore, current usage is here continued.

Populations. This species is comparatively homogeneous in its structure, with the possible exception of the Cuban population. Tables 5-6 in which the dorsal and anal counts are segregated into three major geographic regions, show only slight differences. The population of the northern part of the Gulf averages the highest count, that from Key West to Tampa, inclusive, the lowest, and the population on the Atlantic coast is intermediate, but the differences are slight.

The 2 Cuban specimens examined have 10 caudal rays and 73-77 scales, agreeing with *plagiusa* in these counts. One of them (107365) has D 87, A 71, which counts fall within the range of variation of *plagiusa*, somewhat to the left of a median. The other specimen (37750) has D 92, A 78. The dorsal count of this specimen falls in the last column, on the right of the distribution of the species as a whole, while the anal count falls altogether out of the range of the species. Either the latter specimen is an unusually extreme variant, or the Cuban population of *plagiusa* is markedly variable. Another possibility is that the Cuban population averages higher dorsal and anal counts than the populations on the coast of the United States.

Symphurus piger (Goode & Bean).

Aphoristia pigra Goode & Bean (in part), *Bull. Mus. Comp. Zool.*, 12:154, 1888 (specimens of more than one species included in original account, see below)—Goode & Bean (in part), Ocean. Ichthy., p. 460, pl. 110, fig. 377, 1895 (same specimens listed as in preceding citation).

Symphurus piger Jordan & Goss, Rep. U. S. Comm. Fish., 1886:326, 1889 (after Goode & Bean)—Jordan & Evermann, *Bull. U. S. Nat. Mus.*, 47 (3): 2705, 1898 (after Goode & Bean).

Symphurus pusillus Hildebrand (not Goode & Bean), *Carnegie Inst. Washington Publ.* 535:50, 1941 (Tortugas, Florida).

Description. C 12. D 85-88. A 72-73. Sc 69-74. Teeth on eyed side extending approximately over anterior three-quarters of both jaws. Measurements of 2 specimens 116-133 mm. and 3 specimens 57-98 mm.: caudal 14 (12.5-15.0), depth 33-34 (29.0-30.5), head 22.5-23.0 (23.0-24.5), preanal 28-30 (in all 5), postanal 75-77 (73-74).

Color of the three large Tortugas specimens pale with sharply contrasting, somewhat irregular, rather narrow cross bands. The other three specimens probably more or less faded; the one specimen from off Sombrero Light with one cross band and a small part of another; the lectotype brownish, irregularly shaded with faint traces of darker cross bands. Fins light colored or moderately dusky, moderately marked with darker dots and small elongate or irregular spots.

Caudal rays. The five specimens in which the caudal rays were counted have 12 complete rays.

Specimens examined. Off St. Kitts, W. I. (M.C.Z. 27965, 250 fathoms, the lectotype, 98 mm.). Tortugas (117287, 140-197 fathoms, 2 specimens 115-133 mm., the smaller specimen badly damaged; 117176, no depth record, about 116 mm.), off Sombrero Light (153099, 50-60 fathoms, 62 mm., a teratic specimen having only one eye) and off Palm Beach (153089, 40 fathoms, 57 mm.), Florida.

Comparison. The number of dorsal rays and scales of *piger* falls near the lower end of the distribution of *plagiusa* and *civitatum*, while the anal count falls at or near the middle of their ranges. It differs from those two species in having the dentition on the eyed side better developed, and it differs further from *plagiusa* in having 12 caudal rays. In its structural characters it is nearest *pusillus*. Judged by the specimens examined, *piger* differs from *pusillus* in having fewer scales, a deeper body, longer head and shorter postanal. More extensive samples are needed to elaborate adequately the differences between *piger* and *pusillus*.

Lectotype. Specimens of at least two species were included for certain in the original account of *Aphoristia pigra*, and probably more than two. Specimens are listed from Blake Station XXIII, and Albatross Stations 2318, 2374, 2425 and 2405. As the phraseology used in the original description for type designation is not in consonance with present day taxonomic practice, and a question might be raised as to which species the name *piger* is to be applied, the specimen from Blake Station XXIII, M. C. Z. 27965, is hereby designated as the lectotype. The specimens from Albatross Station 2318, U. S. N. M. 74330, now labeled as cotypes of *A. pigra*, are included above in the account of *parvus*. Also, specimens from Albatross Station 2374 are included above under the account of *minor*, but it is not altogether certain whether they are the same specimens referred to by Goode & Bean. Specimens from the other two stations listed in the original description could not be located now.

Symphurus pusillus (Goode & Bean).

Aphoristia pusilla Goode & Bean, *Proc. U. S. Nat. Mus.*, 8:590, 1885 (off Long Island)—Goode & Bean, Ocean. Ichthy., p. 461, pl. 110, fig. 379, 1895 (based on preceding specimens).

Symphurus pusillus Jordan & Evermann, *Bull. U. S. Nat. Mus.*, 47(3): 2710, 1898 (after Goode & Bean).

Description. C 12. D 85-88. A 71-75. Sc 79-83. Teeth on eyed side rather well developed in both jaws, continuously extending over their anterior half or farther backward. Measurements of 3 specimens 53-59 mm. in standard length, the caudal damaged: depth 28.0-28.5, head 20.5-22, preanal 27-28, postanal 77-81.

The three small specimens examined apparently faded, rather light brownish, with traces of cross bands in two specimens, fins yellowish.

Caudal rays. All 3 specimens have 12 complete caudal rays.

Specimens examined. Off Long Island, New York (28730, Fish Hawk Station 921, Lat. 40° 07′ 48″ N., Long. 70° 43′ 54″ W., 67 fathoms; 28778, F. H. Station 941, Lat. 40° 01′ N., Long. 69° 56′ W., 79 fathoms); the three cotypes, their measurements given above.

Comparison. This species is nearest *piger*

as discussed under the account of that species.

Symphurus marginatus (Goode & Bean).

Aphoristia marginata Goode & Bean (in part), *Bull. Mus. Comp. Zool.*, 12:154, 1886 (specimens from Blake Station CLXXXI and Albatross Station 2376 included in account below; specimen from Fish Hawk Station 1154 included below in account of *nebulosus;* specimens from off St. Vincent not examined)—Goode & Bean (in part), Ocean. Ichthy., p. 459, pl. 110, fig. 376, 1895 (preceding specimens listed).

Symphurus marginatus Jordan & Goss, Rep. U. S. Comm. Fish. 1886:323, 1889 (after Goode & Bean)—Jordan & Evermann, *Bull. U. S. Nat. Mus.*, 47(3): 2706, pl. 387, fig. 949, 1900 (after Goode & Bean).

Symphurus diomedianus Hildebrand (not Goode & Bean), *Carnegie Inst. Washington Publ.* 535:49, 1941 (Tortugas, Florida).

Description. C 12. D 96-98. A 82-83. Sc 92-95. Teeth on eyed side extending over greater part of both jaws. Measurements of 2 specimens 102-127 mm.: caudal 11-13, depth 21.0-22.5, head 17-19, preanal 24-25, postanal 78-80.

Specimens examined probably faded, brownish, traces of rather small, diffuse dusky spots, giving impression of rough arrangement along longitudinal lines; a dark, very fine streak at dorsal and anal base; fins at posterior end of fish dark.

Caudal rays. All 12 rays in the four caudals counted, fully developed.

Specimens examined. Off Mississippi Delta (M. C. Z. 27967, Lat. 28° 42′ N., Long. 88° 40′ W., 321 fathoms, Blake). Off Dauphin Island, Alabama (131634, Lat. 29° 03′ 15″ N., Long. 88° 16′ W., 324 fathoms, Albatross). Besides the above 2 type specimens, their measurements given above, 3 specimens examined from Tortugas, Florida (117174, taken in "197 plus fathoms;" 117288, no depth data); in very bad condition, but body rather slender, fin ray counts about agree with the 2 type specimens, and apparently of the same species. The determinable fin ray counts of the Tortugas specimens included in Tables 1-3 and the account of the species.

Comparison. This is a deep water species. It has the dentition on the eyed side fairly developed as in *piger* and *pusillus* with which it also agrees in having 12 caudal rays. It differs rather widely from those two species in the dorsal, anal and scale counts. The body is slenderer than in any species here treated, except *nebulosus.*

Symphurus civitatum, new species.

Description. C (11) 12. D 87-92. A 70-77. Sc 69-80. Teeth on eyed side of upper jaw extending over anterior half of jaw or less, none on lower jaw. Angle of mouth approximately under posterior margin of lower pupil or middle of eye. Measurements of 10 Gulf specimens 91-147 mm. and 2 Atlantic specimens 121-153 mm., the latter in parenthesis: caudal 10.5-13.5 (10.5-11.5), depth 30-34 (31-32), head 19.5-21.0 (18.0-18.5), preanal 24-26 (22-24), postanal 78-82 (81-82).

Cross bands usually absent or faint, sometimes rather fairly marked; opercle without a black spot, occasionally with a dusky area; caudal and posterior part of dorsal and anal variably dusky, sometimes nearly black.

Caudal rays. Of 36 specimens with 12 caudal rays, 2 have one of the rays represented by a basal ossicle only, the other 34 having 12 complete rays. Two specimens have only 11 complete rays. The latter were taken in 8 and 10 fathoms in company with other specimens of *civitatum* having the normal number of 12 rays. The probabilities favor the conclusion that they are specimens of *civitatum,* but there is some shade of doubt. By long odds they might possibly be examples of *plagiusa.*

Holotype. U.S.N.M. 155227; Pelican Station 77-4; Lat. 29° 06′ 30″ N., Long. 89° 40′ W.; off Mississippi Delta; 9½ fathoms; July 8, 1938; 125 mm.

Paratypes. Other 36 Gulf specimens 91-147 mm., in 19 constituent samples taken off the following localities: Aransas Pass and Galveston, Texas; Calcasieu Pass, Marsh Island, Atchafalaya Bay, Isle Derniere, Grand Isle and Grande Terre, Louisiana; Mobile, Alabama; St. Joseph Bay, Florida. Depth records are available for 16 of these constituent samples and range 4-12 fathoms. Also, 2 specimens 121-153 mm. from the Atlantic, taken at Cape Hatteras, North Carolina, and Cape Canaveral, Florida, in 14 and 10 fathoms, respectively.

Six of the 22 constituent samples examined were separated from a mixture of *civitatum* and *plagiusa.* Of the above specimens the *Pelican* took 23 in 11 constituent samples in the Gulf, all on the coast of Louisiana, and one specimen off Cape Canaveral. Based on the samples examined, this is evidently a moderately offshore species which is fairly common on the northern Gulf coast and not so common on the Atlantic coast.

Comparison. This species is very close to *plagusia.* These two represent allopatric, composite, somewhat intergrading populations, as discussed further under the account of *plagusia,* and it would not be altogether out of place to treat them as two coordinate subspecies. However, the degree of divergence between the two composite populations is high, being at least at the borderline between species and subspecies. The index of divergence, according to the composite samples examined, is 8 when the number of dorsal rays is used as the basis for comparison and 7 when the number of anal rays is used. This degree of divergence seems nearer that of species. At any rate, *civitatum* is here treated as a full species until it and *plagusia,* especially the latter, are more adequately sampled.

For the practical purpose of identification,

civitatum needs to be compared with *plagiusa;* as it occurs through the greater part of the geographic range of that species, the two are sometimes taken together, and the dorsal, anal and scale counts are nearly the same in both. The chief character that distinguishes them is the number of caudal rays, normally 10 in *plagiusa* and 12 in *civitatum,* but this difference is not absolute, as out of 383 specimens examined of both species 10 have 11 rays. Most specimens of these two species are further distinguished by their habitat and by color. *S. civitatum* does not live in shallow water and is not taken in the inner bays or by shore seining in open water. Also, most of the larger, well preserved specimens of *plagiusa* have a black spot on the head, while *civitatum* lacks such a spot. Often these two differences are not applicable. Many specimens of *plagiusa* lack the black spot. Also, while *plagiusa* is the only species of *Symphurus* on the east coast of the United States that inhabits shallow water, it also extends offshore over the range of *civitatum,* and of 82 lots of both species examined, that comprise 2 or more specimens, 6 contained a mixture of both, apparently taken together in the same trawl. Nevertheless, by these two differences, 7 out of the 10 specimens which have 11 caudal rays are confidently referable to *plagiusa* as discussed under that species. That leaves only 3 specimens out of 383, or less than one per cent., about which there is a shade of doubt regarding their proper placement by species. The grounds for placing these 3 specimens by species, one in *plagiusa* and two in *civitatum,* are stated above.

A minor difference between the two species is that in *civitatum* the posterior angle of the mouth is usually slightly more backward with relation to the position of the eye, than in *plagiusa.* This criterion furnishes some slight additional evidence that the 10 variants with 11 caudal rays have been properly placed, 8 and 2 in *plagiusa* and *civitatum,* respectively. However, this character is not decisive, and often specimens cannot be referred to their proper species when it alone is used as a criterion.

Populations. The two Atlantic specimens examined have a shorter head than 10 specimens measured from the Gulf, as indicated above.

Symphurus plagusia

(Bloch & Schneider), sensu lato.

Aphoristia ornata Gunther, Cat. Fish. Brit. Mus., 4:490, 1862 (Atlantic coasts of tropical America).

Symphurus plagusia Jordon & Goss, Rep. U. S. Comm. Fish. 1886:324, 1889 (Havana; Brazil)—Jordan & Evermann, *Bull. U. S. Nat. Mus.,* 47(3): 2709, 1898 (Havana; Brazil).

Description. C (11) 12 (13). D 90-101. A (72) 76-85. Sc 74-92. Teeth on eyed side of lower jaw absent, or a few present in individual variants. Angle of mouth under middle of lower eye or posterior margin of its pupil. Cross bands present or absent; caudal and posterior part of dorsal and anal black or dusky; no definite, well marked spots on caudal, dorsal, anal and opercle.

Distinctive characters and relationship. This species is characterized by the combination of normally having 12 caudal rays, its dorsal, anal and scale counts, the poorly developed dentition on the eyed side and the lack of definite spots on the caudal, dorsal and anal. As here treated, it is divisible into two subspecies, *plagusia* in the West Indies and Central America, and *tessellata* on the coast of Brazil and Uruguay. The index of divergence between the two in the frequency distribution of the dorsal and anal rays (Tables 2-3), amounts to 15, which is of subspecies magnitude.

From one viewpoint *plagusia* might be regarded as a species that extends from the coast of the United States to South America; that is, including *civitatum;* and is composed of a number of diverging populations the degrees of divergence of which differ widely. From this viewpoint the populations of *plagusia,* sensu lato, might be divided into three major groups which might be treated as subspecies, *civitatum* on the coast of the United States, *plagusia,* sensu stricto, in the West Indies and Central America, and *tesselata* on the coast of Brazil and Uruguay. However, the divergence of the population on the coast of the United States is rather abrupt. *S. civitatum* diverges to a greater extent from the subspecies *plagusia* than *tessellata* does from the latter. The degree of divergence of *civitatum* is about that of species magnitude and it is here treated as a full species, as discussed under its account.

Symphurus plagusia plagusia

(Bloch & Schneider).

Plagusia subcinerea, cauda attenuata . . . Browne, The civil and natural history of Jamaica, p. 445, 1789 (Jamaica; non-binomial).

Pleuronectes plagusia Bloch & Schneider, Syst. Ichthy., p. 162, 1801 (based on Browne).

Aphoristia fasciata Goode & Bean (not De Kay), Ocean. Ichthy., p. 458, pl. 110, fig. 374, 1895 (Jamaica).

Description. C (11) 12 (13). D 90-98. A (72) 76-82. Sc 74-90. Dentition on eyed side rather weak; teeth in upper jaw extending over its anterior two-fifths or less; usually no teeth on eyed side of lower jaw, often a few teeth present on side, near its middle or on its anterior third. Measurements of 12 specimens 85-195 mm. and 6 specimens 49-76 mm.: caudal 9-12 (9.5-12.0), depth 27.0-30.5 (25-28), head 19-21 (20.5-22.0), preanal 23-27 (26-28), postanal 77-83 (76-81).

Cross bands usually present, variable, often interrupted or irregular, sometimes faint or imperceptible; caudal and posterior part of dorsal and anal usually black, often

moderately dusky; posterior part of head often with a large dusky area, but no well defined black spot; no distinctive color marks.

Caudal rays. Of the 23 specimens recorded in Table 1 as having 12 rays, one of the rays is incomplete in 3, being in the form of a small basal ossicle in 2 specimens, and as a short stump in one. All 3 imperfect specimens are from Panama. One specimen has 11 and another 13 caudal rays, all complete.

Specimens examined. Taken at or off the following localities: Cuba (35108; M. C. Z. 11200, 11269 and 25982); Jamaica (37348); Haiti (133671); Dominican Republic (108369, 108372); Puerto Rico (50178, M. C. Z. 28843); Porto Bello (81652), Fox Bay (81653-5) and Fort Randolph (144792), Panama; Trinidad (123112). Total examined, 25 specimens, 44-195 mm. Only 2 depth records are available, 17-18 fathoms, for the two specimens taken off the Dominican Republic by the *Caroline*. Some of the others at least apparently were taken by shore seining.

Comparison. The relationship of the subspecies is discussed above under the account of its species.

Populations. This subspecies has a comparatively wide geographic range, and judged by the small samples examined it appears to be markedly heterogeneous. The dorsal and anal counts are segregated by local populations in Tables 5-6. The Cuba and Panama populations average higher counts than those from Hispaniola and Puerto Rico.

Symphurus plagusia tessellata (Quoy & Gaimard).

Plagusia tessellata Quoy & Gaimard, Voy. Uranie, Zool., p. 240, 1824 (Rio de Janeiro).

Plagusia brasiliensis Agassiz, in Spix, Selecta Genera et Species Piscium . . . Brasiliam, p. 89, pl. 50, 1829 (Brazil).

Description. C (11) 12 (13). D 95-101. A 78-85. Sc 80-92. Teeth on eyed side of upper jaw extending approximately over its anterior third; no teeth on eyed side of lower jaw. Measurements of 10 specimens 124-221 mm.: caudal 8.5-9.5, depth 26.0-29.5, head 18.0-19.5, preanal 24-26, postanal 77-84.

Most specimens examined apparently faded, a few specimens perhaps showing about normal color in preservative, or not so faded, having a nearly uniform brownish color, without definite cross bands, and caudal and posterior part of dorsal and anal black or dusky; no distinctive markings.

Caudal rays. Of the 31 specimens entered in Table 1 as having 12 caudal rays, 2 have one of these rays incomplete, represented by a small basal ossicle. One specimen has 2 rays fused at some distance above their bases and 11 complete rays, or a total count of 13. Two specimens have only 11 rays, all of them complete.

Specimens examined. Rio de Janeiro, Santos, Pernambuco and Rio Sao Francisco, Brazil; Uruguay. Total examined, 34 speci-mens, 76-221 mm., all except one from Brazi

Comparison. The relationship of this sub species is discussed under the account o its species.

Nomenclature. The name *ornatus* Lace pède (Hist. Nat. Poiss., 4:659 and 664, 1802) is sometimes used by authors to designat this subspecies, or that name is placed in th synonymy of *plagusia*, sensu lato. Lacépède *ornatus* was based on a specimen the localit of which was unknown. It is described a having a lateral line and 8 or 9 deeply dar bands. It is much more likely that this speci-men came from the Indo-Pacific region tha from the western Atlantic.

Symphurus jenynsi Evermann & Kendall.

Symphurus jenynsi Evermann & Kendal *Proc. U. S. Nat. Mus.*, 31:108, fig. 4, 190 ("probably from the market at Bueno Aires").

Symphurus bergi Thompson, *ibid.* 50:41 pl. 2, fig. 2, 1916 (Montevideo).

Description. C 9-10. D 109-114. A 92-9 Sc 102-118. Beginning to taper posteriorl at about middle of standard length, varyin a little both ways (some evidence to sho shape changing with growth, beginning t taper more posteriorly in the largest speci-men). Teeth on eyed side of upper jaw in small group at a short distance behind sym physis; no teeth on eyed side of lower jaw Measurements of 3 specimens 233-346 mm 9 specimens 165-195 mm. and 5 specimen 128-159 mm., the following proportiona measurements given in three groups in sam order, beginning with largest: caudal 6.5-8. 7.0-8.5, 8-9; depth 27.5-32.5, 26-30, 26.5-29.0 head 15.5-16.5, 16-18, 17.5-19.0; preanal 2 24, 21-24, 23-28, postanal 83-87, 80-86, 78-8

Nearly uniformly colored or irregularl shaded or spotted, the shadings sometime aggregated to form rather diffuse cros bands; fins moderately dusky; no distinctiv markings.

Caudal rays. In the 21 specimens counte all the caudal rays are fully developed, in cluding the two variants having 9 such ray

Specimens examined. Buenos Aires, A gentina (55573, type of *jenynsi*, 181 mm. Other 21 specimens 117-346 mm., in 10 con stituent samples, including the type of *berg* (76852), all taken on the coast of Urugua at or off Montevideo and Isla de Flores definite depth records not available, prob ably taken both inshore and offshore. Thi is evidently a common species on the coas of South America.

Comparison. This species is readily dis tinguished from the others here treated b its high dorsal, anal and scale counts in com bination with the presence of 9-10 cauda rays.

Symphurus nebulosus (Goode & Bean).

Aphoristia nebulosa Goode & Bean, *Bul Mus. Comp. Zool.*, 10:192, 1883 (off Charle

ton, South Carolina)—Goode & Bean, Ocean. Ichthy., p. 458, pl. 110, fig. 375, 1895 (based on type specimen).

Aphoristia marginata Goode & Bean (in part), *Bull. Mus. Comp. Zool.*, 12:154, 1886 (specimen from Fish Hawk Station 1154 belongs to *nebulosus*).

Description. C 14. D 109-113. A 94-98. Sc 123-128. Teeth on eyed side extending over anterior half or greater part of both jaws. Body notably elongate. Upper lobe of head notably small, lower lobe large and notably projecting beyond lower. Measurements of 3 specimens 45.5-77.5 mm. in standard length, the caudals damaged: depth 21.5-23.5, head to apex of upper lobe 19.0-20.5, to apex of lower lobe 21.0-23.5, preanal 27-30, postanal 73-75.

Almost uniformly colored, reddish or yellowish brown, the three available specimens perhaps faded, side of abdomen black, apparently the black peritoneum showing on the outside; no distinctive markings.

Caudal rays. The 3 specimens examined have 14 complete rays.

Specimens examined. Fish Hawk Station 1154; Lat. 39° 55′ 31″ N., Long. 70° 39′ W.; off Long Island, New York; 193 fathoms (152842). Blake Station 316; Lat. 32° 7′ N., Long. 78° 37′ 30″ W.; off Charleston, South Carolina; 229 fathoms (M. C. Z. 27966, the holotype). Albatross Station 2664; Lat. 29° 41′ N., Long. 79° 55′ W.; off Matanzas Inlet, Florida; 373 fathoms (84490). Measurements of these 3 specimens given above.

Comparison. This species differs from all others here treated in having 14 caudal rays. The scales are more numerous than in all other species, approaching *jenynsi* in this character. In the number of dorsal and anal rays it about agrees with *jenynsi* and differs from all other species. In its notably slender body, it about agrees with *marginatus* and differs from the others. Altogether, it is a very distinctive, readily recognizable species.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. A. *Symphurus minor;* from the holotype; U. S. N. M. 131643; off St. George Island, Florida; 42 mm.

Fig. B. *Symphurus parvus;* from the holotype; U. S. N. M. 84491; off Boca Chica, Florida; 73 mm.

Fig. C. *Symphurus pelicanus;* from a paratype; U. S. N. M. 155235; off Padre Island, Texas; 70 mm.

PLATE II.

Fig. D. *Symphurus urospilus;* from the holotype; U. S. N. M. 155225; off Savannah, Georgia; 136 mm.

Fig. E. *Symphurus pterospilotus;* from the holotype; U. S. N. M. 87770; Isla de Flores, Uruguay; 127 mm.

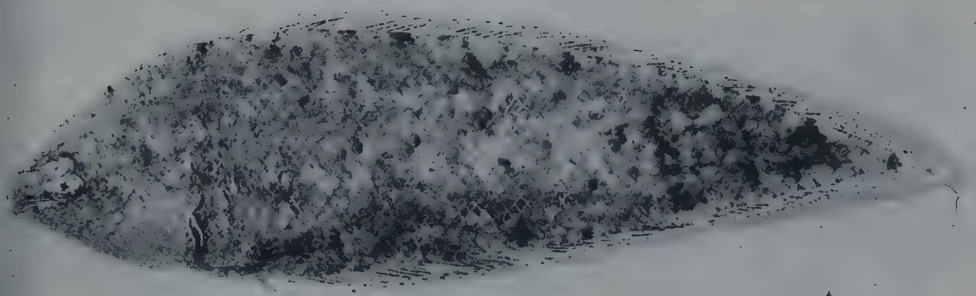
Fig. F. *Symphurus diomedianus;* from the holotype; U. S. N. M. 37347; off Tortugas, Florida; 152 mm.

PLATE III.

Fig. G. *Symphurus plagiusa;* U. S. N. M. 154962; off Cumberland Island, Georgia; 123 mm.; many specimens lack black opercular spot.

Fig. H. *Symphurus civitatum;* from the holotype; U. S. N. M. 155227; off Mississippi Delta; 125 mm.

Fig. I. *Symphurus civitatum;* a well marked banded variant; U. S. N. M. 120081; Galveston, Texas; 125 mm.



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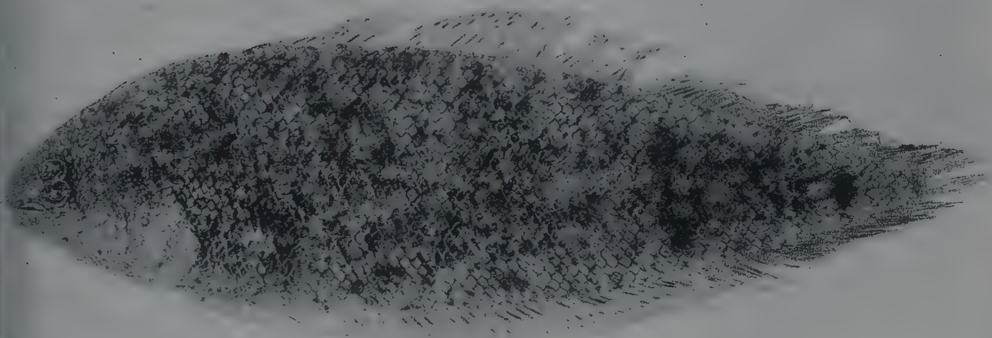

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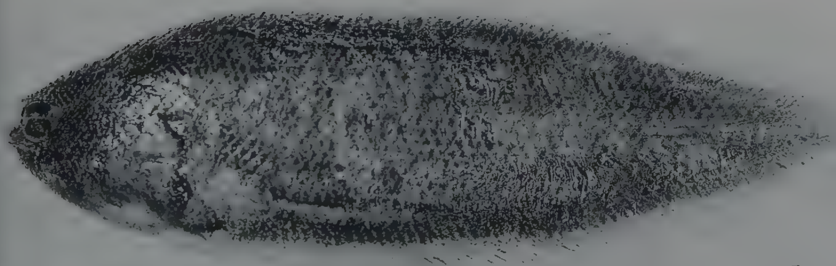
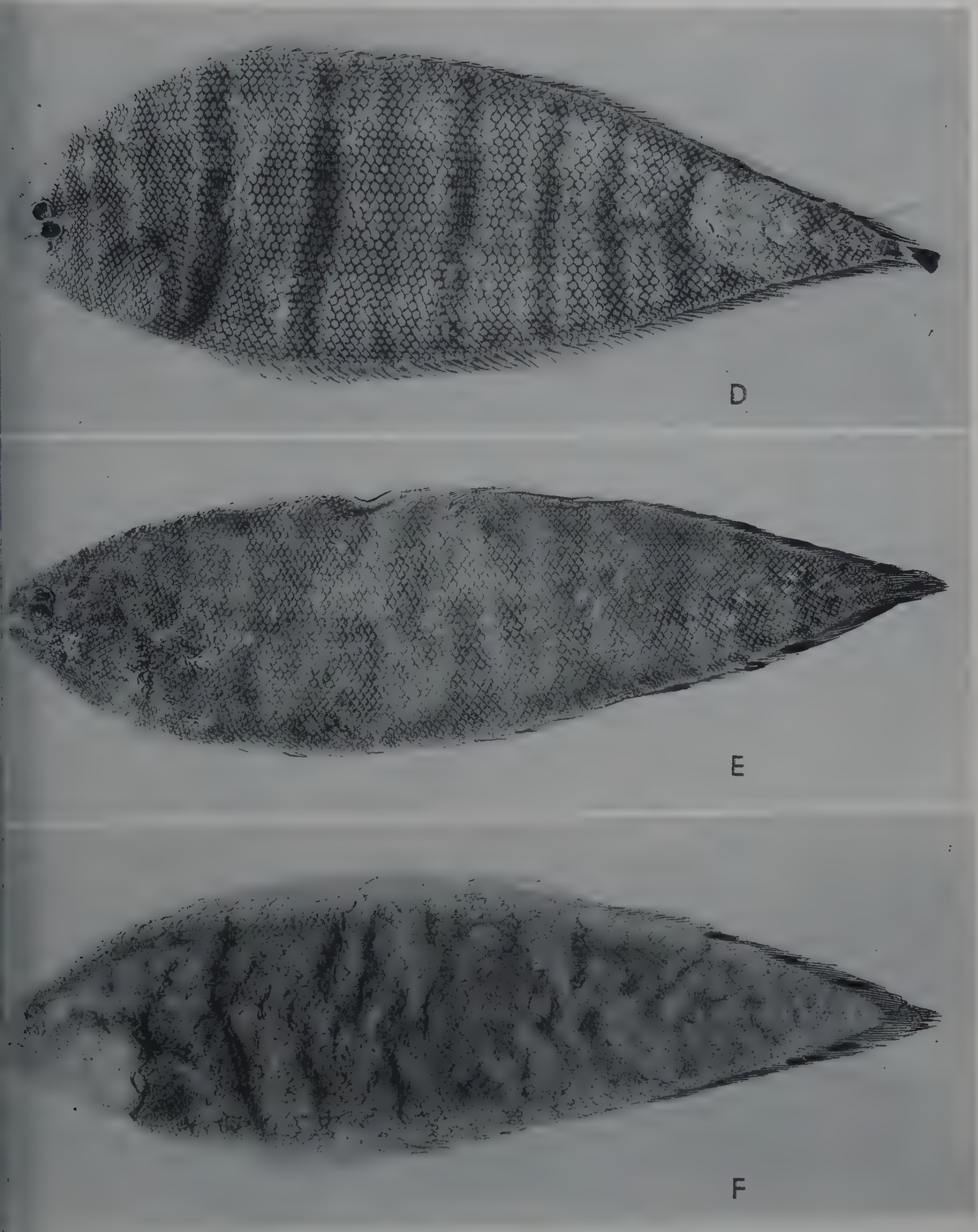
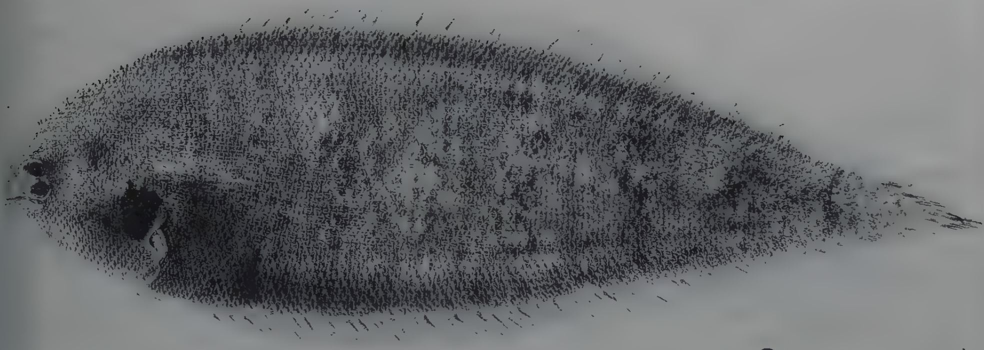


C

WESTERN ATLANTIC TONGUEFISHES WITH DESCRIPTIONS OF SIX NEW SPECIES.



WESTERN ATLANTIC TONGUEFISHES WITH DESCRIPTIONS OF SIX NEW SPECIES.



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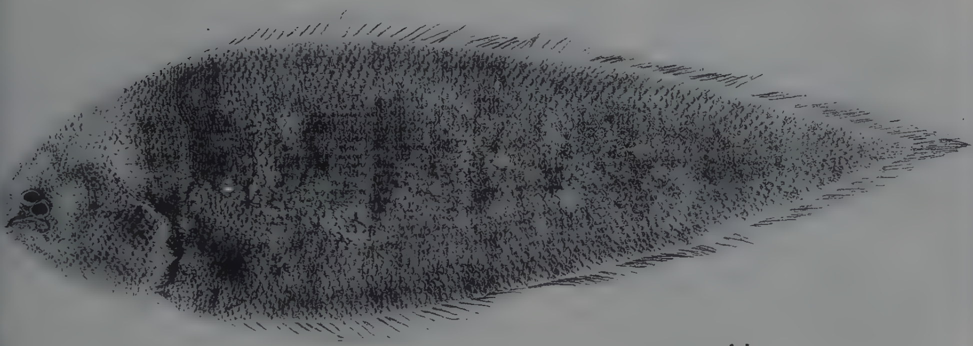

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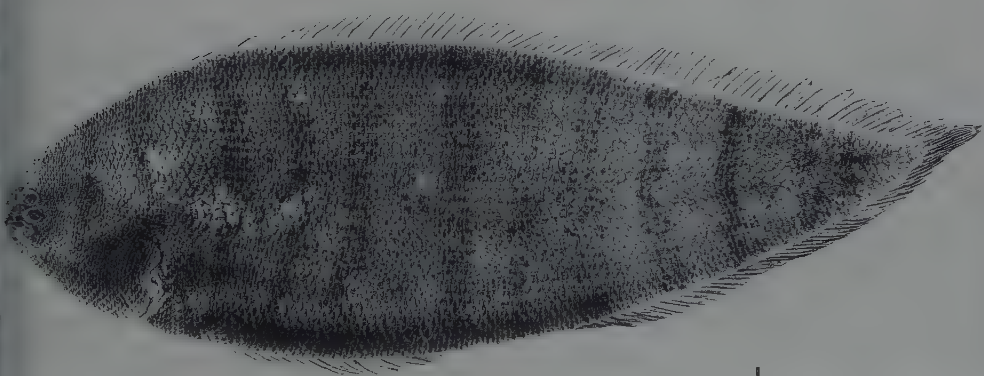

I

WESTERN ATLANTIC TONGUEFISHES WITH DESCRIPTIONS OF SIX NEW SPECIES.

15.

Agglutinins and Agglutinogens in the Blood of Wild Animals.

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Jewish Memorial Hospital.[1]

INTRODUCTION.

Through the use of serology, a number of authors (Irwin & Cole, 1936 a, b; Irwin, Cole & Gordon, 1936; Zuckerman & Suderman, 1935; Boyden, 1934; Nutall, 1904) have been able to show phylogenetic relationships between animals of various groups, giving further support to the Linnaean method of classification. In other instances, previously unknown factors were discovered in the blood of animals which have been of extreme importance in the clinical and medico-legal fields (Landsteiner & Wiener, 1940; Landsteiner & Levine, 1928).

Three methods are used in the study of blood groups: Immune serum prepared for the blood cells of one animal is tested with the blood cells of another related or unrelated animal; blood cells and serum belonging to the same species are cross-typed to determine the presence of isoagglutinins; and cells and serum of different species are cross-typed to determine whether heteroagglutinins are present.

With human cells, the presence of group-specific agglutinins may be determined. Such studies might reveal factors common to the blood of man and other animals. The importance of these studies is not of taxonomic interest alone, since similar investigations led to the discovery of important human blood factors (Landsteiner & Wiener, 1940) which were later found related to *erythroblastosis fetalis*, a hemolytic jaundice of the newborn.

Early methods of systematic serology utilized the ring precipitin test (Zuckerman & Suderman, 1935; Boyden, 1934; Nutall, 1904). Further refinements of this test (Boyden & DeFalco, 1943; Boyden, 1943; DeFalco, 1942) involved the use of the photoelectric nephelometer to measure the volume of precipitate formed.

Later investigators used cross-agglutination tests with the blood cells of one animal and the serum of another. This was a simple test that copied the cross-agglutination technics of blood typing and was used to study guinea pigs, mice (Boyd & Walker, 1934; McDowell & Hubbard, 1922) and rats (Rhodenburg, 1919). None of these investigations revealed evidences of isoagglutinins in any of these animals. Studies on rabbits (Levine & Landsteiner, 1931; Levine & Landsteiner, 1929; Snyder, 1924) showed that normal isoagglutinins were absent from such animals when tests were conducted at 37° C., but such agglutinins could be demonstrated after repeated transfusions between rabbits of the same species.

Normal isoagglutinins were found in chickens (Landsteiner & Levine, 1932; Karschner, 1928 b). The former authors used normal chicken serum and the latter used normal ox serum to differentiate the groups.

Isoagglutinins found in horses (Herman, 1936) could be used to divide the animals into definite blood groups similar to those found in humans. Relationship between the horse and closely related species was investigated by Walsh (1924) while studies of bovines (Little, 1929; Karschner, 1928 a) showed the presence of ill-defined groups in these animals.

Irregular heteroagglutinins and isoagglutinins were demonstrated in certain members of the Reptilia (Bond, 1939; 1940 a, b).

Studies of heteroagglutinins for the blood of man revealed the presence of weak agglutinins for all four groups of human cells in the sera of rabbits (Stuart, Sawin, Wheeler & Battey, 1936; Friedenreich & With, 1933; Hooker & Anderson, 1921) while specific agglutinins for certain human blood groups have been found in bovines (Karschner, 1928 a), chickens (Karschner, 1928 b), reptiles (Bond, 1939; 1940 a, b) and various monkeys (Buchbinder, 1933; Landsteiner & Miller, 1925 a, b, c).

Through the use of specially adsorbed rabbit immune serum, other blood factors have been discovered. These have been named P (Landsteiner & Levine, 1931 b), M (Wheeler & Stuart, 1939; Wiener, 1938; Landsteiner & Wiener, 1937; Landsteiner & Levine, 1928; 1931 a) and Rh (Landsteiner & Wiener, 1940).

In relation to the large number of species of animals, and especially mammals, only a relatively few have been examined from the serological point of view. Since there is access to exotic species of mammals in our great zoological gardens, it was thought worth while to make an attempt to study the blood groups in captive wild animals.

The present investigation was carried out to determine whether any agglutinins exist-

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ed, in the sera of certain captive wild and domesticated animals, for the blood cells of man. Where agglutinins for human cells were found, agglutinin adsorption tests were performed to ascertain whether these agglutinins were heterogenetic or specific for any human blood group.

Human sera was also used against the blood cells of different animals to see if such sera had agglutinins for the blood cells of the animals tested. Where such agglutinins were found, it was further determined whether the adsorption of human sera by these blood cells would remove any of the normal human isoagglutinins.

Since the work of Landsteiner & Wiener (1940) has resulted in valuable information on Rh blood groups, work along similar lines is certainly of importance.

Material and Methods.

Blood was collected and allowed to clot. The serum was separated by centrifuging and inactivated for thirty minutes at 37° C. One drop of serum (approximately 0.1 cc.) and one drop of blood cells in 0.85% sodium chloride (approximately 0.5% concentration) were added to a test tube 12 × 75 mm. The tubes were shaken for twenty minutes on a Kahn shaker and were then centrifuged at low speed (1500 R.P.M.) for three minutes. By gentle rocking, the button of cells on the bottom of the tube was dislodged and a reading made.

A firm clot of unbroken clumps was recorded as four plus; the formation of a few smaller clots which were still red on macroscopic examination was recorded as three plus; smaller clots which could be still noticed macroscopically but did not show the definite red color, were recorded as two plus. One plus readings were not clearly visible on macroscopic examination. All specimens giving less than two plus agglutination were read under the microscope at 100 diameters and were designated as one plus, doubtful or negative.

In tests with the Rh sera there was no shaking. The mixture of cells and serum was incubated at 37° C. for two hours, using equal volumes of serum and packed animal cells that were washed three times with 0.85% sodium chloride. The serum and cells were separated by centrifuging and the adsorbed serum was set up against human cells known to agglutinate in non-adsorbed serum of the same type.

Where agglutination occurred between the serum of an animal and human cells, that serum was adsorbed at room temperature for two hours by one-half of its volume of washed, packed human cells of type A, B or O. The adsorbed serum was cross-typed with other human cells to determine whether the anti-human agglutinins had been removed.

Where agglutination took place between the cells of an animal and human serum, that serum was adsorbed by the animal cells in the same manner previously mentioned. The adsorbed serum was then set against othe human cells to determine whether the no mal human isoagglutinins were adsorbe out by the animal cells.

The blood of two hundred and fifty ind viduals was tested against the blood of thi teen different animal species to determin whether the human sera contained ant bodies for the animal blood cells and whethe the human blood cells were agglutinated b the sera of the species used.

The animals were the following: (I) Pr mates — Diana Monkey (*Cercopithec diana*), Philippine Macaque (*Macaca irus*), Ring-tail Monkey (*Cebus capucina*), Hum boldt's Woolly Monkey (*Lagothrix humbold tii*), Baboon (*Papio* sp), and Chimpanze (*Pan troglodytes*); (II) Rodentia—Com mon Albino Rabbit (*Ocyctolagus cuniculus*) and Guinea Pig (*Cavia porcellus*); (III Carnivora — Puma (*Felis concolor*) an Kinkajou (*Potos flavus*); (IV) Artioda tyla—Dromedary (*Camelus dromedarius*), Dwarf Buffalo (*Anoa depressicornis*) an sheep (*Ovis aries*).

Acknowledgements.

I wish to express my appreciation to D Ross F. Nigrelli, of the New York Zoologic Society, under whose direction this work wa carried out while the author was a studen at New York University. I also wish to than Dr. Leonard J. Goss, Veterinarian of th New York Zoological Park, and Dr. Harr Wallerstein and Mr. Nathan Schwartz of th Jewish Memorial Hospital, New York Cit for their cooperation in supplying materia for this study. To Dr. Ralph J. DeFalco o Rutgers University, my thanks for man helpful suggestions and for editing th manuscript.

Results.

Diana Monkey.

The sera of three Diana Monkeys wer found to agglutinate human type B cel specifically. This anti-B agglutinin could b adsorbed out of the Diana sera by type cells only. Adsorption by any other type o human cells failed to remove the B aggl tinins.

Three specimens of type O+ human cel tested with the serum from a Diana Monke gave doubtful agglutination. The serum o the other two monkeys did not clump Grou O blood cells.

The agglutination of cells of three Dian Monkeys by human sera varied with th serum used but no definite group pattern wa shown. Adsorption of human serum by Dian erythrocytes did not remove the normal is agglutinins from the human serum. Adsor tion of anti-Rho (85%) and anti-Rh′ (70% sera by Diana blood cells did not remove th Rh antibodies since such adsorbed sera wou continue to agglutinate Rh-positive cells o the appropriate type. Anti-Rh″ (30% serum was adsorbed with the blood cells o

nly one Diana Monkey and this adsorption lso failed to remove the anti-Rh'' antiodies.

Philippine Macaque.

The serum of one Philippine Macaque was ested against the blood of nineteen indiiduals. Only the cells of Groups A and AB vere agglutinated. Adsorption of the serum y Group A cells removed all of the agglu-inins for human cells.

Woolly Monkey.

The serum of one Woolly Monkey was set p against a number of human cells of all ypes. In no case was any human cell agglu-inated. The adsorption of anti-Rh_0 (85%), h' (70%) and Rh'' (30%) sera by the lood cells of the Woolly Monkey failed to emove the Rh antibodies.

Ring-tail Monkey.

The sera of three Ring-tail Monkeys ag-lutinated all human cells with which they vere tested but not with equal intensity. Cells of Group A and AB were more strongly gglutinated than cells of the other two roups. Adsorbing these sera either with Group O or Group B blood cells removed the gglutinins for Groups O and B but not for Group A. Adsorption by Group A blood cells emoved agglutinins for all groups. Thus here are two antibodies in the serum of the Ring-tail Monkey, a heteroagglutinin for all uman cells and a specific anti-A agglutinin.

The cells of four Ring-tail Monkeys were gglutinated strongly by the sera of forty-ight individuals. Adsorbing normal human sera with Ring-tail Monkey cells did not remove the normal human isoagglutinins, since such adsorbed sera still agglutinated cells of the appropriate blood groups. Adsorption of anti-Rh_0 (85%), anti-Rh' (70%) and anti-Rh'' (30%) sera with Ring-tail cells also failed to remove the Rh agglutinins from these antisera.

Baboon.

The serum of one Baboon agglutinated the cells of all human blood groups with which it was tested. Another serum gave doubtful agglutinations with one specimen of O— and one specimen of A— cells. Adsorption experiments showed that one Baboon serum lost all of its agglutinins after adsorption with cells of Groups O—, A— or B—. The other Baboon showed agglutinins for B— cells after being adsorbed with O— cells and weak A agglutinins after being adsorbed by cells of Group A.

All specimens of human serum agglutinated Baboon cells strongly, regardless of type. Adsorption of human sera and of anti-Rh_0 (85%), Rh' (70%) and Rh'' (30%) sera by Baboon cells failed to remove the normal agglutinins from such sera.

Chimpanzee.

The serum of one Chimpanzee agglutinated the cells of all human groups except Group O. One specimen of Group AB— also failed to agglutinate. Adsorption of Chimpanzee serum with Group AB cells removed all of the human agglutinins.

Rabbit.

Experiments with Rabbit blood showed that Rabbit serum agglutinated human cells with varying intensity, depending upon the serum and cells used. Thus a specimen of Rabbit serum may agglutinate one sample of type B blood and not another.

Human sera set up against Rabbit cells gave the same type of reaction. The intensity again varied with the cells and serum used and no definite pattern could be shown where agglutination occurred or failed to take place.

The adsorption of human sera by Rabbit cells failed to remove the normal human isoagglutinins from the sera.

The Rabbits used in these experiments were previously used for pregnancy tests. It has been shown (Witebsky & Klendshoj, 1940, 1941) that Group B and Group O specific substances could be isolated from the gastric fluid and saliva of some individuals. It is possible that these substances are present in the urine of some individuals and the injection of urine from Group B or Group O individuals into Rabbits may have increased the anti-human agglutinins in the blood of these animals.

Guinea Pig.

Guinea Pig serum from two animals failed to agglutinate any of the twenty-two specimens of human blood used in the tests.

Guinea Pig blood cells were agglutinated by all of the forty specimens of human sera used. Adsorption of human sera by the Guinea Pig cells failed to remove the normal isoagglutinins present in such sera. Adsorption of anti-Rh_0 (85%), anti-Rh' (70%) and anti-Rh'' (30%) with Guinea Pig cells also failed to remove the anti-Rh agglutinins.

Puma.

The serum of the Puma agglutinated one specimen each of Type A and B, Rh-positive and Rh-negative blood. There was no agglutination of Type O cells. This anti-A agglutinin could be adsorbed out of the Puma serum by Type A human cells only. The anti-B agglutinin could be adsorbed out only by Type B cells. In the case of the B adsorption, a weak agglutinin still remained in the adsorbed Puma serum for one specimen belonging to Group B.

Thus the Puma has a specific anti-A and anti-B agglutinin. No heterogenetic agglutinins were found.

Some specimens of human Type A and O sera agglutinated Puma cells. Type B and AB sera failed to do so.

Kinkajou.

The serum of one Kinkajou failed to agglutinate any of the human cells used. Adsorp-

tion of anti-Rh_0 (85%), anti-Rh′ (70%) and anti-Rh′′ (30%) serum by the Kinkajou's cells failed to remove the anti-Rh agglutinins.

Dromedary.

The results of testing Dromedary cells with human sera showed that most specimens of sera were capable of agglutinating the erythrocytes. Only an occasional human serum failed to cause clumping. Adsorption of human sera by Dromedary cells failed to remove the normal human isoagglutinins from such sera.

Dwarf Buffalo.

The cells of the Dwarf Buffalo were agglutinated by the sera of eighteen individuals, representing seven human blood groups. Adsorption of these sera by the cells of the Buffalo failed to remove the normal human isoagglutinins present in such sera.

Sheep.

All human cells were agglutinated strongly by the sera of three sheep. The results of the agglutination adsorption tests were, however, erratic.

Adsorption of sheep sera with O— cells removed all of the anti-O agglutinins. In one sheep, adsorption by Group O cells removed the A and B agglutinins for some blood belonging to those groups. Adsorption with A, B or AB cells did not necessarily result in the removal of these agglutinins from the sheep serum. It was not possible to predict whether adsorption by the cells of any one group would remove agglutinating factors for that group, since some cells of the same type were still agglutinated. In some cases, adsorption by cells of one group removed the agglutinins for another group but still left agglutinating factors for different specimens of the same group.

The intensity with which sheep cells were agglutinated by human sera varied with the specimen. The greatest proportion of human sera agglutinated the sheep cells strongly.

Adsorption of human sera with sheep ce failed to remove the normal human isoaggl tinins since the adsorbed sera still was ca able of agglutinating cells of the appropria type.

Table 1 is a composite showing the resul obtained with human cells and the sera of t various animals used in these experiment Table 2 shows the results obtained with h man sera and animals cells. Table 3 show agglutinins present in animal sera that a adsorpable with human cells.

Agglutination showing three and four pl reactions are indicated by the signs ++ the tables. Those giving one plus and tw plus reactions are indicated by +. An "0 indicates a negative reaction, a "?" indicat a doubtful reaction. Where the space is blan no tests were made.

Discussion.

Thirteen different species representi four orders of mammals, Primates, Rodenti Carnivora and Artiodactyla, were studie Of the animals investigated, the Pum Dromedary and Dwarf Buffalo have nev before been studied for their agglutinin a agglutinogen content.

No new blood factors were determined the methods used, but agglutinins for huma blood cells were present in the sera of mo of the animals used. Human sera aggluti nated nearly all the cells of the animals us and failure to produce such agglutinati did not follow any specific pattern. Wheth or not the use of rabbit immune sera wou give the same results is not known, but ma of the newer blood factors have been disco ered by such means.

There were no blood factors common to a species, and members of the same speci did not necessarily react in the same mann to human sera. However, using animal se against human cells, similar results were o tained in some instances when the serum identical species was used.

The sera of members of the same famil but different genera, did not necessarily a

TABLE 1.

Animal Sera Versus Human Blood Cells.

Human Cells	Diana Monkey	Philippine Macaque	Woolly Monkey	Ring-tail Monkey	Baboon	Chimpanzee	Guinea Pig	Puma	Kinkajou	Sheep
0+	0	0	0	+	? ++	0	0	0	0	++
0–	0	0	0		++	0	0	0	0	++
A+	0	++	0	++	? +	++	0	++	0	+ ++
A–	0	++	0	++	+ ++	+	0	++	0	++
B+	++	0	0	+ ++	++	+	0	++	0	++
B–	++	0			++		0	++	0	
AB+		++	0	++	++	0 ++	0		0	++
AB–	++	++	0	++		++				++

TABLE 2.
Human Sera Versus Animal Blood Cells.

Human Sera	Diana Monkey	Ring-tail Monkey	Baboon	Rabbit	Guinea Pig	Puma	Dromedary	Dwarf Buffalo	Sheep
0+	++	++	++	++	++	0	+	++	? ++
0–	++	++	+++	++	++	0 +	++	++	++
A+	0 +++	++	++	+++	++	0 +	+	++	+++
A–	+++	++	++		++	0 ++	0 ++	++	0 +++
B+	++	++	++	++	++	0	+	++	+++
B–	0 ++		++		++	0	++	++	++
AB+	+++	++	++		++		0 +	++	++
AB–	++			++					

TABLE 3.
Agglutinins Adsorpable by Human Cells.

Serum of:	Human Blood Cells				Remarks
	0–	A–	B–	AB–	
Diana Monkey	–	–	+		Beta agglutinins present
Philippine Macaque		+			Alpha agglutinins present
Woolly Monkey					No agglutinins present
Ring-tail Monkey	+(1)	+(2)	+(1)		Specific Alpha agglutinins (see below)
Baboon	+(3)	+(3)	+		Heterogenetic agglutinins O,A,B, present in serum of one Baboon (see below)
Chimpanzee				+	Alpha and Beta agglutinins adsorbed by one specimen of AB– cells
Puma	–	+(4)	+(5)		(See below)
Sheep	+	+(6)	+(7)	+(8)	(See below)
Guinea Pig					No agglutinins present
Kinkajou					No agglutinins present
Rabbit					(See 9 below)

(1). These agglutinins are heterogenetic and can be removed by O or B cells.
(2). The agglutinin is specific and removable by type A cells only.
(3). Weak Beta agglutinins in 1 specimen removed only by B blood cells.
(4). Anti-A only removed.
(5). Removed most anti-B, leaving feeble anti-B+. Did not remove anti-A.
(6). Removed anti-A– but not anti-A+.
(7). Removed anti-B+ in some serum specimens but not in others.
(8). Some AB– adsorption removed anti-A, O or B in some specimens, but this adsorption did not occur with all serum specimens.
(9). Heteroagglutinins present. Type present varied with the specimen of serum. The same specimen of serum would agglutinate type B+ cells of one individual and fail to agglutinate type B+ cells of another individual.

A "+" sign indicates that agglutinins present are removable by the blood cells of the type shown.

alike. For example, in the family Cercopithecidae, the two Baboons (*Papio* sp.) showed heterogenetic agglutinins, but one had an anti-B agglutinin in addition to this. Three Diana Monkeys, *Cercopithecus diana,* showed only anti-B agglutinins in their sera, while one Philippine Macaque, *Macaca irus,* showed only anti-A agglutinins. It would be interesting to determine whether members of the same genus would fall into similar groups. Landsteiner & Miller (1925 c) did show that 22 members of 12 species of Platyrrhina all gave strong agglutination with their purified agglutinating solutions prepared from Group II (A) and Group III (B) human sera. In these experiments different results were obtained on identical species. However, the difference was undoubtedly due to the fact that unmodified human sera was used in cross-typing with animal cells. Though agglutination took place in nearly all instances, it was shown by agglutinin adsorption tests that the agglutination was heterogenetic and the blood cells of these animals were incapable of adsorbing out the normal human isoagglutinins from human sera. The agglutinogens in the blood cells of these animals were not identical to those in human cells.

Studies of the Diana Monkey are in complete agreement with those of Landsteiner & Miller (1925 c). No agglutinogens were found in the blood cells of the Diana which resembled those in human blood. All agglutinations were heterogenetic. The serum of the Diana Monkey was able to specifically agglutinate Groups B and AB human cells only. That this was specific and not heterogenetic was shown by the fact that the anti-human red cell agglutinins in the Diana Monkey could be adsorbed only by human Group B cells.

Using purified agglutinating sera, Landsteiner & Miller (1925 c) were able to show that agglutinogens similar to B were absent from the Cercopithecidae. Diana is a member of this family. It would not be expected that a B type agglutinogen would be present in an animal possessing an anti-B agglutinin in its serum.

With the Philippine Macaque, agglutinins were present in the serum for human A and AB cells only. These could be specifically adsorbed out only by Group A cells. Since the A agglutinin is similar to the Forssman heterophile agglutinin (Landsteiner & Miller, 1925 c) and the Macacus is heterophile negative (Buchbinder, 1933) and does contain anti-A or anti-heterophile agglutinin in its serum, the results followed those of the two aforementioned authors.

The sera of two Baboons showed heterogenetic agglutinins for all human cells. One Baboon also had a strong specific anti-B agglutinin which could be adsorbed out only by Group B human cells. A weak anti-A antibody, still present after adsorption with Group A cells but not after adsorption by Groups O or B cells, was probably due to insufficient adsorption with the Group A cells used. It was not possible to repeat this experiment because of the small amount of Baboon serum available at the time of the test. Since Landsteiner & Miller (1925 c) failed to find an agglutinogen similar to human B in the Cercopithecidae, it is possible for an anti-Group B agglutinin to exist within members of this family. This is shown by the Diana Monkey and the Baboon. This agglutinin need not necessarily be present since the Macaque lacks the B antigen and the B agglutinin in its blood.

Agglutinogens similar to the human B were demonstrated in the cells of Platyrrhina (Landsteiner & Miller, 1925 c). On this basis there should not be any anti-B agglutinins in the sera of these animals. In the sera of three Ring-tail Monkeys (*Cebus capucina*) there were two anti-human agglutinins present: a heterogenetic antibody and a specific anti-A agglutinin. The heterogenetic antibody could be adsorbed out of the serum to type O human cells. Such adsorption did not remove the anti-A agglutinin. This could be removed by type A cells alone. The one specimen of the Woolly Monkey also failed to agglutinate any human cells, showing complete absence of heterogenetic or group specific antibodies in its serum.

The serum of one Chimpanzee contained agglutinins for human A and B cells. This would be expected on the basis of the work of Landsteiner & Miller (1925 b) who found that the similarity of Chimpanzee and human blood was so close that adsorption of human B sera with human Group A blood cells also removed the agglutinins for the Chimpanzee blood cells. They classified the Chimpanzee as belonging to groups similar to the human A and O groups. The one Chimpanzee studied here seems to belong to Group O on the basis of the agglutinins present in its serum. These A and B agglutinins were removed by adsorption with human AB cells. Landsteiner & Miller (*loc. cit.*) used purified agglutinating solutions on animal cells. In these experiments, unaltered sera was used. Since agglutinogens similar to human B have been demonstrated in the Platyrrhina (Landsteiner & Miller, 1925 a, b, c), it would not be expected that specific anti-B substances would be found in the sera of these animals. The two species of the genera *Cebus* and *Lagothrix* did not have specific B antibodies in their sera.

Since B agglutinogens were absent in the family Cercopithecidae, it was possible for B antibodies to exist in the sera of members of this family. Two members, *Papio* sp. and *Cercopithecus diana,* had specific B agglutinins while the third member, *Macaca*, lacked the B antibody in its serum.

The work on rabbits confirms the work of Hooker & Anderson (1921), who also demonstrated agglutinins for human cells in the sera of the rabbit. Further agreements were

own in the greater activity of these sera their action toward A and B cells than ward O cells. These authors further stated at human isoagglutinin beta in Group I O) and Group II (A) sera can be adsorbed y rabbit cells, resulting in a fall of the titre f such adsorbed human sera. This adsorp-on is not complete since undiluted adsorbed uman sera still maintains sufficient normal uman isoagglutinin to cause strong agglu-ination with the appropriate cells.

One difference between the experiments of Iooker & Anderson (1921) and those of this aper is that the rabbits used for these ex-eriments had been previously injected for regnancy tests. It is possible that the in-ection of human urine into the rabbits may ave increased the anti-human agglutinin itre of the rabbit. However, the results ob-ained are substantially the same as those f Hooker & Anderson (1921).

B agglutinins were found to a greater ex-ent in these experiments than in those of Friedenreich & With (1933). These authors ound that a strong anti-B agglutinin was resent in the undiluted sera of three of orty-seven rabbits. Our results are not in greement with those obtained by these uthors.

As noted above, the rabbits had been pre-viously injected with human urine. This may have increased the anti-B titre of the rabbit sera where such specimens of urine came from Type B individuals.

The sera of two Gunea Pigs failed to ag-glutinate any of twenty-two different cells, representing all four human blood groups, although human sera of all groups consist-ently agglutinated the blood cells of the Guinea Pig.

The Puma was the only member of the Carnivora examined whose serum showed anti-A and B agglutinins. These were specific and could be adsorbed by cells of the appro-priate type only. The blood cells of the Puma were agglutinated by three specimens of hu-man sera of seventeen used. Two of these were from human Group A and one from human Group O.

Studies of sheep gave erratic results. All sheep sera agglutinated all specimens of hu-man blood cells. Adsorption of sheep sera by human blood cells of one group would, in some cases, remove the agglutinins for that group alone, while in other instances it would remove the agglutinins for other groups as well. In other experiments, adsorption by one type of blood cells still left agglutinins for other specimens of the same human blood group. There was no predictable manner in which the sera would respond to agglutina-tion and agglutinin adsorption tests with hu-man cells. Possibly sheep serum contains ag-glutinins for sub-groups so that adsorption by one type of human blood cell still left ag-glutinins for certain of these sub-types.

The action of human sera on sheep cells varied from strong agglutination to no ag-glutination. No relation could be demon-strated between the blood group and the result of the agglutination test. The sheep cells did not remove the normal human iso-agglutinins from human sera, since such adsorbed sera was still capable of agglutinat-ing cells of the appropriate type.

Some phylogenetic significance is shown since the monkeys used in these experiments fall into two categories: those possessing an anti-B agglutinin and those lacking it. Those with the B agglutinin in their blood are members of the Cercopithecidae. However, the absence of this antibody for human Group B cells did not necessarily preclude membership in a different family.

The new world monkeys, *Cebus* and *Lago-thrix*, did not have an anti-B agglutinin. Since agglutinogens similar to Type B were demonstrated in their cells by Landsteiner & Miller (1925 c), such antibodies would not be expected.

The *Macaca*, which did not have an anti-B agglutinin, did have a Group A antibody. It is interesting to note that Buchbinder (1933) mentions this anti-A agglutinin in *Macaca rhesus* and the same antibody has been found here in *Macaca irus*. Though two species are not enough from which to draw conclusions, it would be of interest to determine whether all members of the same genus have the same anti-human agglutinins in their blood.

Approaching the problem of systematic serology from a different point from that taken by Boyden (1934, 1942), who per-formed precipitin tests with immune and normal serum of related species, and having cognizance of the small number of animals examined in these experiments, the results obtained with Primate sera and human cells support the views of Boyden (1942) that serology may be used to investigate the "generally accepted principles of systematic zoölogy" (Boyden, *loc.cit.*).

It is possible to classify the animals stud-ied, especially the Primates, into groups on the basis of the presence or absence of anti-human red cell agglutinins in their sera. The presence of anti-human Group B agglutinin seems to correspond to membership in the family Cercopithecidae, though the absence of this B antibody does not exclude member-ship in the same family.

The presence of an anti-human Type A agglutinin in the blood sera of the primates does not lend itself as easily for use in the classification as does the presence of the anti-B. Two members of the genus *Macaca, M. irus* and *M. rhesus*, both have A agglutinins in their sera while three different specimens of Ring-tail Monkey, *Cebus capucina*, also possessed specific human A agglutinins.

The use of modified agglutinating solu-tions of Landsteiner & Miller (1925 c) and unmodified sera as used in the present inves-tigations could be added to the procedure of Boyden (1934, 1942) using immune animal sera.

Conclusions.

Within the limits of the technic and the animals used, the following results were obtained:

The intensity with which the serum of an animal agglutinates the cells of another related or unrelated animal is a characteristic of the individual specimen. With human sera there was no relation between the blood group and the avidity with which it agglutinated animal cells.

It is not possible to classify into blood groups the animals studied, using the agglutination of their blood cells by human sera as a criteria.

Normal isoagglutinins in human sera cannot be completely adsorbed out by the blood cells of the animals studied nor can the anti-Rh factors in human anti-Rh sera be removed by similar technics. The Rh factor was discovered through the injection of rabbits with *Macaca rhesus* blood cells. This agglutinogen is absent in the blood cells of the monkeys studied, as indicated by the fact that anti-Rh_0, anti-Rh′ or anti-Rh″ did not lose their agglutinins after adsorption with the blood cells of the monkeys used in these studies.

The agglutination of human blood cells by the sera of the animals used is either group specific, heterogenetic or a combination of both factors. These specific human blood cell agglutinins can be adsorbed out of the animal sera with human erythrocytes of the appropriate type. This is the first time that studies have been made with known Rh-positive and Rh-negative cells. None of the animals used in these experiments had normal agglutination antibodies to Rh.

On the basis of agglutinins for human blood cells in their sera, it is possible to assign the animals studied in these experiments to groups: anti-B group—Diana Monkey and Baboon; anti-A group—Philippine Macaque and Ring-tail Monkey; anti-AB group — Chimpanzee and Puma. Another group consisting of those possessing agglutinins for all human blood groups and unclassifiable types will include the rabbit and sheep. Since some of the animals studied, the Philippine Macaque and Diana Monkey for example, possess agglutinating antibodies for only one type of human blood group, it is possible to use the sera of such animals for typing human blood. Those animals possessing agglutinins for more than one human blood group may, in some instances, be used for blood typing if they are selectively adsorbed by appropriate human cells before use.

Summary.

The blood cells and sera of humans were cross-typed with the blood cells and sera of thirteen different animals species. Where agglutination occurred, agglutinin adsorption experiments were carried out to determine whether such agglutination was het rogenetic or group specific.

In eight of the eleven animal sera studie agglutinins for human blood cells wer found. The presence or absence of thes agglutinins could be used to classify the an mals into groups.

In most cases human sera agglutinate the blood cells of the animals studied. Failu to cause agglutination, or the intensity o the reaction, was in no way related to th human blood group of the serum used.

Insofar as is known, this study report the use of Rh-negative and Rh-positive cel for the first time in the examination of th sera of the animals used in the experimen Th presence of specific anti-A and anti- agglutinins in the Puma is also reported fo the first time.

The blood cells of the animals used in thes experiments cannot adsorb out normal hu man isoagglutinins or anti-Rh factors fro human serum. The methods used in thes studies did not reveal the presence of an Rh agglutinogen in the species utilized.

The sera of some of the animals showin specific anti-human red cell agglutinins ca be used for typing human blood.

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16.

Parasites of Fish in the Upper Snake River Drainage and in Yellowstone Lake, Wyoming.

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During July and part of August in the seasons of 1949 and 1950 a study was made of fish parasites in the Jackson Hole area and in Yellowstone Lake, Wyoming. This survey was supported in part by grants from the New York Zoological Society and the collecting and preliminary identifications were done at the Jackson Hole Research Station of the New York Zoological Society.

In the two periods 2,535 fish belonging to 14 different species were examined and 2,351 or 92.3 per cent. carried at least one species of parasite. Many of these fish were obtained by seining. Assisting in collecting were members of the laboratory group for the two seasons. Special acknowledgment for aid is given to Dr. N. A. Meinkoth, Mr. Harold Hagen, Mr. James R. Simon and to my daughter Jean. Fishermen and the guides and boatmen at Jackson Lake docks assisted in collecting the game species. The specimens from Yellowstone Lake were obtained through the cooperation of the fish hatchery superintendent at Lake Station, and the creel census workers and Dr. Oliver B. Cope of the U. S. Fish and Wildlife Service.

Most of the fish were examined while fresh with the aid of a dissecting microscope. After the external parts, eyes and gills had been examined, the viscera were searched for encysted and internal parasites, then the viscera and contents were placed in a container with an approximately 0.7 per cent. solution of sodium bicarbonate and shaken vigorously.

Then the viscera were removed, the solution poured off and the concentrated parasites picked out from a petri dish under the binocular microscope. For a portion of the Yellowstone Lake cutthroat trout and for all of the Jackson Lake mackinaw trout, only the viscera, pectoral fins and gills were available for examination. Acanthocephala were allowed to die in water before being preserved. All parasites were preserved in 5 per cent. formalin after the larger forms had been killed in hot 10 per cent. formalin. The parasites were stained in Delafield's haematoxylin and mounted for study. After preliminary study and tentative identification, the acanthocephalan forms were submitted to Dr. H. J. Van Cleave, the parasitic copepods to Dr. William Tidd and the gill flukes to Dr. J. D. Mizelle. All of the identifications in the present report are those of the author except for one identification of a leech by Dr. Marvin C. Meyer.

The small number of fish species obtained and the fact that there were not many different types of habitats limited the numbers of various parasite species to less than that taken in previous surveys by the writer: northern Wisconsin (1946), Algonquin Park Lakes (1941a; 1946), southern Florida (1941b) and Reelfoot Lake (1942).

The table below lists the forms frequently encountered in several different fish species. An asterisk in front of the name indicates a larval encysted stage.

TABLE I.
Parasites Frequently Encountered.

	Number of species of fish
Trematoda	
Allocreadium lobatum	8
**Posthodiplostomum minimum*	7
Crepidostomum farionis	6
Gyrodactyloidae	6
**Diplostomum* sp.	5
**Neascus* sp.	4
**Clinostomum marginatum*	4
Cestoda	
**Diphyllobothrium* spp.	4
**Ligula intestinalis*	3
Proteocephalus laruei	2
Nematoda	
**Contracaecum spiculigerum*	6
Rhabdochona sp.	6
Bulbodacnitis scotti	4
**Bulbodacnitis scotti*	4
Metabronema salvelini	4
**Philonema agubernaculum*	3
Hepaticola bakeri	3
Capillaria catenata	2
Acanthocephala	
Neoechinorhynchus spp.	5
Copepoda	
Ergasilus sp.	4
Salmincola sp.	2
Protozoa	
**Ichthyophthirius multifiliis*	4
*Myxosporidia	2

Strigeid metacercariae were found to be widely distributed in the minnows and dace but were infrequently taken from suckers;

trout and whitefish. *P. minimum* was found to be encysted in a majority of hosts including plains longnose dace, Bonneville spring dace, Utah chub and Utah silverside minnow. All of 86 northern suckers from Pelican Creek, near Yellowstone Lake, had eye flukes *Diplostomum* sp. The same or a related species of *Diplostomum* was found in a smaller number of hosts in four other fish species. *Ligula intestinalis* was found in 19 of 73 chubs taken in 1950 from Emma Matilda Lake. It was taken from relatively few chubs and suckers from other areas. The Utah chubs from Two Ocean Lake showed a higher infection with the yellow grub, *Clinostomum marginatum,* and with the protozoan *Ichthyophthirius multifiliis* than chubs from 15 other areas.

The Utah chub yielded the greatest number of different parasite species, 25 being taken from 670 hosts in 15 locations in the two seasons. At one time during 1950 many chubs were lost as a result of a mixed infection of *I. multifiliis* and gyrodactylid flukes.

Young rosyside suckers, Utah chubs, Utah silverside minnows and Bonneville spring dace from Jackson Lake showed lighter infections than the same host species from many other areas. This may have been due to frequent changes in water levels and consequent interruptions in life cycles of the parasites.

A number of interesting parasite infections were encountered among the species of trout from different areas but these will be reported on in the discussion of distribution of parasites by species of fish, which follows.

The species of fish are arranged according to J. R. Simon (1946), "Wyoming Fishes." The species of parasites are listed in order of frequency of occurrence. The number following each name indicates the number of fish which harbor the parasite. Encysted larval forms are indicated by a single asterisk (*) while immature stages within the digestive tract are marked by a double asterisk (**).

1. Rocky Mountain Whitefish.
Prosopium williamsoni williamsoni (Girard).

(Examined 23; infected 23).

Proteocephalus laruei	17
Allocreadium lobatum	8
Gyrodactyloidae	7
**Philonema agubernaculum*	5
Achtheres coregoni	4
Crepidostomum farionis	3
Metabronema salvelini	1
Bulbodacnitis scotti	1
**Diplostomum* sp.	1

All of the hosts were secured from Whiteman Creek or the Snake River near Moran, Wyoming, by hook and line. Most specimens of the cestode *P. laruei* were immature. The nematode *P. agubernaculum* was taken from cysts in the mesentery or near the liver surface. As many as 7 were secured from a single host. This species was described by Simon & Simon (1936) from Wyoming *Prosopium williamsoni, Salvelinus fontinalis* and *Salmo shasta.*

2. Yellowstone Cutthroat Trout.
Salmo clarkii lewisi (Girard).

(Examined 291; infected 278).

Crepidostomum farionis	207
Bulbodacnitis scotti	149
**Diphyllobothrium* spp.	119
Salmincola sp.	50
Metabronema salvelini	39
Allocreadium lobatum	31
**Bulbodacnitis scotti*	26
Glochidia (*Margaretifera margaretifera*)	8
**Posthodiplostomum minimum*	3
Myxosporidia (gills)	2
***Proteocephalus laruei*	2
**Agamospiura* sp.	2
**Apophallus* sp.	1
Gyrodactyloidae	1
Hepaticola bakeri	1
Illinobdella sp.	1

Adult hosts were examined from Yellowstone Lake, Snake River, Lake Solitude, Two Ocean Lake, Flat Creek, Game Creek and young individuals from Polecat and Glade Creeks. The 135 cutthroat trout from Yellowstone Lake were obtained from those dead or injured at the traps in Pelican Creek and from viscera and gills preserved by the creel census workers at Fishing Bridge and the boat docks at West Thumb.

All of 53 hosts from the Fishing Bridge and Pelican Creek area were parasitized. The following lists gives the number of hosts parasitized. The degree of the infections was light to moderate.

B. scotti (53)
C. farionis (49)
Myxosporidia (gills) (1)
**B. scotti* (5)
**Diphyllobothrium* spp. (47)
Salmincola sp. (8)

From the West Thumb portion of the lake the following findings were obtained in 82 hosts:

B. scotti (82)
C. farionis (71)
Illinobdella sp. (1)
Salmincola sp. (40)
**B. scotti* (12)
Diphyllobothrium spp. (71)
*Myxosporidia (1)

The nematode *B. scotti,* found free in the intestine of all these hosts and encysted in large, round cysts in 17, was a species described by Simon (1935) for the same host from Yellowstone Lake. Thirteen cutthroat trout from Game Creek, below Jackson, yielded 12 with intestinal nematodes, *B. scotti,* while 9 of the same hosts carried numerous large membrane-covered cysts of this species on the liver or in the mesenteries about the intestines. The original stock had come from the Yellowstone Lake Hatchery. Only 8 cutthroat out of the 139 infected hosts from other areas yielded this nematode.

Cysts of *Diphyllobothrium* spp. were with one exception all from Yellowstone Lake

hosts. They were of more than one type. Scott (1935) says that the plerocercoids are of three or possibly four types. Almost all of the cysts found were in the mesentery cysts or in the muscle wall of the stomach or intestine. There were very few forms in the flesh. However in a majority of these hosts it was not possible to examine the flesh. There were at least two or three quite different types of plerocercoids recovered from the cysts.

The parasitic copepod *Salmincola* sp. resembled *S. edwardsi* in general characteristics but was found in a different position on the hosts and it was not taken from its usual host in Wisconsin (unpublished data). In the Wisconsin hosts only brook trout were infected and then damage to the gills and operculum was often marked. In the infections with the *Salmincola* for the hosts being discussed in this report, most were found attached inside the pectoral fin. A few were fastened to the gill bars. All but two of the hosts with *Salmincola* sp. were from Yellowstone Lake.

C. farionis was the fluke obtained from nearly all of the hosts except those from Lake Solitude, a small glacier-fed lake at an elevation of 9,020 feet. Cutthroat trout had been planted here by individuals who carried up the cans of young hatchery fish. In 1949 all of 15 trout bore only *A. lobatum* and in 1950 only 16 of 26 from Lake Solitude were infected with this fluke. All were adult and the infection must have been brought in when the fish were planted. Cascade Creek drains from Lake Solitude. Four brook trout were examined from this small mountain stream and two bore *A. lobatum*. All also had adults of another trematode, *C. farionis*. Out of those examined, only one other trout, a cutthroat from Snake River, bore *A. lobatum*.

Another localized infection was that of the young cutthroat trout examined from Polecat Creek, a stream flowing into the Snake River just south of Yellowstone Park. In 1949 glochidia were found as gill cysts on 8 of 10 fingerling trout and in 1950 the two young cutthroat trout that were examined also bore similar glochidia. The only clam in the stream is *Margaretifera margaretifera*. *M. salvelini* was found in the stomach and upper intestine of several hosts from Snake River, Two Ocean Lake and Polecat Creek. The form described by Chandler (1931) was first assigned to the genus *Cystidicola* but afterwards was transferred by Skinker (1931) to the genus *Cystidicoloides*. The species parasitic in trout have been re-examined by Chouquette (1948) and on the basis of the characters of the postcloacal papillae and the spicules, the following species should be regarded as synonymous:

Metabronema (= *Spiroptera*) *salvelini* Fudita (1920)
Metabronema harwoodi Chandler (1931)
Metabronema canadense Skinker (1931)
Metabronema truttae Bayliss (1935)

3. Brook Trout.
Salvelinus fontinalis fontinalis (Mitchill).

(Examined 140; infected 108).

Crepidostomum farionis	105
**Diphyllobothrium* sp.	4
Metabronema salvelini	4
Allocreadium lobatum	2
**Contracaecum spiculigerum*	1
Bulbodacnitis scotti	1

The hosts infected with *Diphyllobothrium* sp., *C. spiculigerum* and *B. scotti* all came from the Lewis River in the Yellowstone Park. Nine of the 10 brook trout from here carried *C. farionis* and one *M. salvelini*. The parasitism of the brook trout from Cascade Creek was already mentioned. In the trout examined from five other locations, three had *M. salvelini* and 94 of 120 had intestinal flukes, *C. farionis*.

4. Brown Trout.
Salmo trutta fario Linnaeus.

(Examined 4; infected 4).

Crepidostomum farionis	3
**Bulbodacnitis scotti*	1
**Philonema agubernaculum*	1

Three of the hosts came from Jackson Lake and one from the Snake River.

5. Rainbow Trout.
Salmo gairdnerii irideus Gibbons.

(Examined 1; infected 1).

Crepidostomum farionis	1

The single host was taken by hook and line at Sublette Lake.

6. Mackinaw Trout, Lake Trout.
Cristivomer namaycush namaycush (Walbaum).

(Examined 184; infected 175).

Bulbodacnitis scotti	145
Crepidostomum farionis	56
Metabronema salvelini	6
Neoechinorhynchus sp.	4
Salmincola sp.	2
**Diphyllobothrium* sp.	2
Eubothrium salvelini	2
Hepaticola bakeri	2
**Philonema agubernaculum*	1
Cystidicola stigmatura	1
Nephelopsis obscura	1

All of these hosts came from Jackson Lake. The degree of infection in the hosts was relatively light, with very few encysted forms. One unusual case of parasitism was that of the leech, *N. obscura*, found within the air bladder of an adult mackinaw trout.

7. Mountain Sucker.
Pantosteus jordani Evermann.

(Examined 22; infected 0).

These fish came from beaver ponds near Jackson Lake Lodge and from Pacific Creek.

8. Rosyside Sucker.
Catostomus fecundus Cope & Yarrow.
(Examined 227; infected 182).

**Neascus* sp.	80
Gyrodactyloidae	56
Caryophyllaeus tetebrans	38
**Diplostomum flexicaudum*	28
Neoechinorhynchus sp.	25
**Posthodiplostomum minimum*	12
**Contracaecum spiculigerum*	11
**Ichthyophthirius multifiliis*	8
*Myxosporidia	8
**Clinostomum marginatum*	5
**Ligula intestinalis*	3
Rhabdochona sp.	2
**Tetracotyle* sp.	2
Ergasilus sp.	1
Allocreadium lobatum	1
Actinobdella triannulata	1
Pomphorhynchus bulbocolli	1
Triganodistomum sp.	1

All of 38 adult hosts were parasitized. Most of these fish came from the Snake River. The fingerlings came from 9 different locations in Jackson Lake, Polecat Creek, Pacific Creek, String Lake, Glade Creek and other streams near Moran. Most of the encysted parasites were secured from the young hosts. Thirty-six adults from the Snake River, taken in 1949 and 1950, had the following numbers infected with the parasites listed: *C. tetebrans* (35), **C. spiculigerum* (3), **D. flexicaudum* (26), *Myxosporidia (2), *Neoechinorhynchus* sp. (18), *P. bulbocolli* (1), *Rhabdochona* sp. (1).

9. Northern Sucker, Eastern Longnose Sucker.
Catostomus catostomus catostomus (Forster).
(Examined 86; infected 86).

**Diplostomum flexicaudum*	86
***Rhabdochona* sp.	7
**Bulbodacnitis scotti*	4
**Ligula intestinalis*	1
**Posthodiplostomum minimum*	1

All of these northern suckers were taken from traps in Pelican Creek where the sucker runs to spawn at the same time as the cutthroat trout. Park authorities believe that these suckers may have been introduced by fishermen who employed them for bait (Simon, 1939). The fact that so few hosts were parasitized, except for the presence of the eye flukes, and that there were no adult intestinal forms, would indicate these fish were not native to Yellowstone Lake.

10. Plains Longnose Dace.
Rhinichthys cataractae ocella Garman.
(Examined 27; infected 27).

**Posthodiplostomum minimum*	26
**Neascus* sp.	11
Rhabdochona cascadilla	9
Gyrodactyloidae	3
**Contracaecum spiculigerum*	2
Allocreadium lobatum	1

The hosts came from five streams in the Jackson Hole area.

11. Bonneville Spring Dace.
Rhinichthys osculus carringtonii (Cope).
(Examined 343; infected 341).

**Posthodiplostomum minimum*	313
**Neascus* sp.	67
Rhabdochona cascadilla	29
Gyrodactyloidae	15
Hepaticola bakeri	11
**Eustrongylides* sp.	11
**Ichthyophthirius multifiliis*	10
**Contracaecum spiculigerum*	3
**Clinostomum marginatum*	2
Allocreadium lobatum	2
Neoechinorhynchus sp.	1
Ergasilus caeruleus	1
Capillaria catenata	1

The dace came from 15 different lakes and streams. The hosts from Ditch Creek and Kelly Warm Springs carried the cysts of *Eustrongylides* sp. *H. bakeri* was secured from a few hosts at Two Ocean and Spring Lakes. The gill flukes were taken from daces in Glade Creek and Jackson Lake.

12. Utah Chub.
Gila straria (Girard).
(Examined 670; infected 660).

**Posthodiplostomum minimum*	587
Rhabdochona cascadilla	302
**Clinostomum marginatum*	100
Glaridacris laruei and 2nd spp.	86
Neoechinorhynchus rutili	83
**Contracaecum spiculigerum*	76
**Diplostomum* sp.	62
Ergasilus caeruleus	59
Allocreadium lobatum	59
**Ichthyophthirius multifiliis*	57
**Ligula intestinalis*	30
Proteocephalus ptychocheilus	28
**Diplostomulum* sp.	13
**Neascus* sp.	11
**Eustrongylides* sp.	11
Lebouria cooperi	10
Gyrodactyloidae	5
**Diphyllobothrium* sp.	3
Capillaria catenata	3
**Hymenolepis* sp.	2
*Myxosporidia	2
**Tetracotyle* sp.	2
Triganodistomum attenuatum	1
Crepidostomum sp.	1

The mature chubs were chiefly taken from Emma Matilda and Two Ocean Lakes and the Snake River. Young Utah chubs came from most other locations where fish were collected, except the cold mountain streams. The mature cestode *P. ptychocheilus* has so far only been reported for the squawfish or chauppal, *Ptychocheilus oregonensis* (Rich.) from the Bitter Root Valley at Carlton, Mont. This form was first described as a new species by Faust (1919). I have found no other published reports of the occurrence of this species. In the Jackson Hole area the distribution was limited to a few hosts from almost all of the locations where Utah chubs were collected. *Lebouria cooperi* has previously been reported for cyprinids and darters from Ohio streams and Lake Erie and more recently from Wisconsin (Bangham, unpub-

lished data). The species was described by Hunter & Bangham (1932).

The one species of Cestodaria is identified as *G. laruei* and the second is similar to *C. tetebrans*. The size and other differences have prevented positive identification as yet.

The cysts of *Hymenolepis* sp. were secured from hosts in Emma Matilda Lake.

13. Utah Silverside Minnow.
Richardsonius balteatus hydrophlox (Cope).

(Examined 479; infected 434).

**Posthodiplostomum minimum*	381
Rhabdochona cascadilla	119
**Neascus* sp.	68
**Contracaecum spiculigerum*	28
Gyrodactyloidae	28
**Clinostomum marginatum*	11
Ergasilus caeruleus	9
*Myxosporidia	8
Lebouria cooperi	7
Allocreadium lobatum	4
Capillaria catenata	3
Cestodaria	3
Neoechinorhynchus rutili	2
Proteocephalus ptychocheilus	1
**Diplostomum* sp.	1

The Utah silverside minnows came from 20 different collecting areas. The most heavily infected group came from those collected at Polecat Creek where all of 60 were infected with a total of 8 parasite species.

14. Blob, Rocky Mountain Bullhead.
Cottus semiscaber (Cope).

(Examined 50; infected 24).

**Tetracotyle* sp.	18
**Posthodiplostomum minimum*	3
***Creptotrema* sp.	2
Metabronema sp.	2
Crepidostomum sp.	1
Lebouria cooperi	1

These tiny hosts were quite free from parasites except for strigeid cysts of *Tetracotyle* and *P. minimum*. The few flukes were nearly all immature.

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17.

Report on a Collection of Spiders and Harvestmen from Wyoming and Neighboring States.

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(Text-figures 1-50).

The report that follows lists the species of spiders and harvestmen collected for the most part in the Black Hills region of South Dakota and the Jackson Hole and Yellowstone regions of Wyoming. Since few lists of spiders of this region are available, it was thought advisable to list the common as well as the rarer species found, together with the new species described. To make the list more usable to the ecologist, an attempt has been made to refer each species to an illustrated description of recent date rather than to follow the usual procedure of giving reference only to the original description of the species. The species of spiders whose female genitalia (epigyna) or palps have not been pictured before, or whose figures could be found only in literature difficult to obtain, have been illustrated here.

The authors hereby thank the staff of the Jackson Hole Biological Station of the New York Zoological Society for help and contributions to their collections, and expecially Dr. D. C. Lowrie who permitted them to examine some of the spiders of his collection. Dr. R. V. Chamberlin has loaned a specimen. Dr. W. J. Gertsch has determined some of the more difficult species and has loaned some under his care for the purpose of making drawings. Special thanks are due to them and to Mrs. C. Crocker for help in obtaining literature.

The types of spiders described here as new have been deposited in the American Museum of Natural History, New York, N. Y.

The following abbreviations, apart from the usual abbreviations for Wyoming and South Dakota, have been used in the text:

CUSTER PARK — Custer State Park, Custer County, South Dakota.

DEVILS TOWER — Devil's Tower National Monument, Crook County, Wyoming.

TETON FOREST—Teton National Forest, Teton County, Wyoming.

TETON PARK — Grand Teton National Park, Teton County, Wyoming.

YELLOWSTONE—Yellowstone National Park, Wyoming.

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CLASS ARACHNIDA.

Order Phalangida.

HARVESTMEN.

PHALANGIIDAE.

Homolophus biceps (Thorell), 1877.
Text-fig. 1.

Roewer, 1923, p. 880.—Comstock, 1940, p. 71.

WYO.: DEVILS TOWER. TETON PARK: Garnet Canyon (elev. 9,000 ft., in talus); Holly Lake (elev. 9,400 ft.); Cottonwood Creek (river bottom); Moran (aspen grove, inside building); Pilgrim Creek near U. S. highway 287 bridge (pine, spruce and cottonwood forest); Signal Mountain (lodgepole forest); Two Ocean Lake (elev. 7,000 ft., lodgepole forest). TETON FOREST: Brooks Mountain (elev. 10,300 ft., alpine meadow under rocks); Mt. Baldy.

Leiobunum paessleri Roewer, 1910. ?

Roewer, 1923, p. 896, fig. 1053.—Davis, 1934, p. 684, figs. 25, 29.

WYO.: TETON PARK: Indian Paintbrush Canyon (elev. 7,500 ft.), one doubtful female.

Order Araneae.

SPIDERS.

OCHYROCERATIDAE.

Usofila oregona Chamberlin & Ivie, 1942.

Chamberlin & Ivie, 1942, p. 8, fig. 8.

WYO.: TETON PARK: Emma Matilda Lake (in lodgepole forest).

THERIDIIDAE.

COMB-FOOTED SPIDERS.

Allotheridion differens (Emerton), 1882.

Theridion differens Kaston, 1948, p. 103, figs. 123-124, 144-145, 2016.

WYO.: TETON PARK: Leigh Lake; Emma Matilda Lake (on sagebrush); Signal Mountain (on shrubs in lodgepole forest);

Jackson Lake northwest of Moran (on sagebrush); Moran.

Allotheridion ohlerti (Thorell), 1870.
Text-figs. 3, 7 & 8.

Theridion simulatum Emerton, 1926, p. 115, figs. 1, 2.

WYO.: YELLOWSTONE: Pebble Creek Camp Ground. TETON PARK: Emma Matilda Lake (on vegetation in open lodgepole forest).

Allotheridion zelotypum (Emerton), 1882.

Theridion zelotypum Emerton, 1882, p. 11, pl. 1, figs. 4-4a. ♀.

T. zelotypum Kaston, 1948. (in part) p. 109, fig. 150. ♂.

WYO.: TETON PARK: Two Ocean Lake; along Snake River near Moran (on trees in very wet woods).

Dipoena sp.

WYO.: TETON FOREST: Mt. Baldy.

Lithyphantes albomaculatus (De Geer), 1778.

Kaston, 1948, p. 78, figs. 47-50.

WYO.: TETON PARK: Pilgrim Creek (under drift wood); Uhl Hill. TETON FOREST: Gros Ventre Slide.

Steatoda hespera Chamberlin & Ivie, 1933.

Chamberlin & Ivie, 1933, p. 9, figs. 4-6.

WYO.: YELLOWSTONE: Indian Creek (in forest). TETON PARK: Wildlife Park; along Snake River; Moran (on building). TETON FOREST: Mt. Baldy.

Theridion marmorata (Hentz), 1850.

Enoplognatha marmorata Kaston, 1948, (in part) p. 77, figs. 35, 38.

WYO.: TETON PARK: Blacktail Butte.

Theridion sexpunctatum Emerton, 1882.

Emerton, 1882, p. 12, pl. 2, fig. 5.

WYO.: YELLOWSTONE: Pebble Creek Camp (lodgepole forest). TETON PARK: Cottonwood Creek. TETON FOREST: Mt. Baldy.

LINYPHIIDAE.

Sheet-web Weavers and Dwarf Spiders.

Bathyphantes pullatus Cambridge, 1863.

B. kuratai Chamberlin & Ivie, 1947a, p. 54, figs. 70, 71.

WYO.: TETON PARK: Cottonwood Creek (river bottom).

Bathyphantes latescens (Chamberlin), 1919.

Chamberlin & Ivie, 1933, p. 34, figs. 119-120.

WYO.: TETON PARK: Cottonwood Creek (along river bottom).

Bathyphantes pallida (Banks), 1892.

Kaston, 1948, p. 131, figs. 301-306.

S. DAK.: CUSTER PARK: near Game Lodge.

Centromerus cornupalpis
(O. P. Cambridge), 1875. ?

Kaston, 1948, p. 136, figs. 316-318.

WYO.: TETON PARK: Signal Mountain (lodgepole forest).

Ceratinella brunnea Emerton, 1882. ?

Crosby & Bishop, 1925, p. 7, fig. 1.

WYO.: YELLOWSTONE: Pebble Creek Camp.

Cochlembolus alpinus (Banks), 1896.

Crosby, 1929, p. 79, figs. 1-4.

WYO.: TETON FOREST: Brooks Mountain (elev. 10,300 ft., alpine meadow, under stones).

Cochlembolus pallidus (Emerton), 1882. ?

Crosby & Bishop, 1933, p. 168, figs. 232-237.

WYO.: TETON PARK: Signal Mountain (in lodgepole forest); Emma Matilda Lake (on sagebrush).

Cornicularia clavicornis Emerton, 1882. ?

Crosby & Bishop, 1931, p. 365, figs. 18-23.

WYO.: TETON PARK: Emma Matilda Lake (lodgepole forest).

Cornicularia sp.

WYO.: TETON PARK: Signal Mountain.

Diplocentria bidentata (Emerton), 1882.

Scotoussa bidentata Bishop & Crosby, 1938, p. 87, figs. 69-71.

WYO.: TETON PARK: Emma Matilda Lake.

Disembolus chera (Chamberlin & Ivie), 1933.

D. stridulans Chamberlin & Ivie, 1945a, p. 226, figs. 14-18.

WYO.: TETON PARK: Lake Solitude (elev. 9,024 ft.); Amphitheater Lake (elev. 9,750 ft.), (Probably under stones in alpine meadows).

Dismodicus decemoculatus (Emerton), 1882.

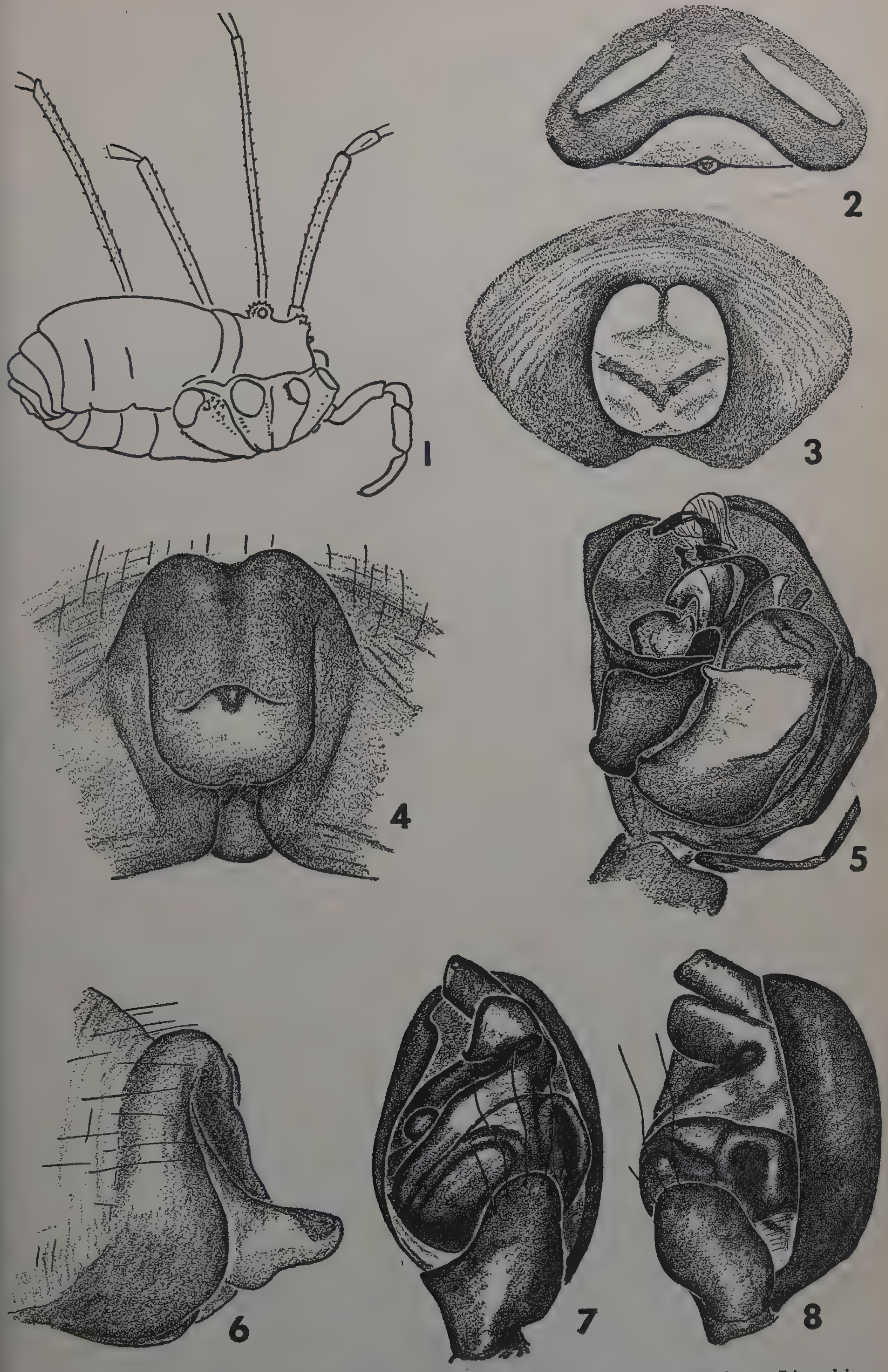
Crosby & Bishop, 1933, p. 149, figs. 165-169.

WYO.: TETON PARK: Two Ocean Lake (on vegetation in lodgepole forest).

Erigone denticulata
Chamberlin & Ivie, 1939.

Chamberlin & Ivie, 1939, p. 57, fig. 2.

WYO.: TETON PARK: Moran (aspen grove).



TEXT-FIGS. 1-8. 1—*Homolophus biceps* (Thorell), lateral view of animal. 2—*Linyphia litigiosa* Keyserling, epigynum. 3—*Allotheridion ohlerti* (Thorell), epigynum (specimen from Finland). 4—*Lepthyphantes chamberlini* Schenkel, epigynum, ventral view. 5—*Linyphia litigiosa* Keyserling, palp, ventral view (specimen from Calif.). 6—*Lepthyphantes chamberlini* Schenkel, epigynum, lateral view. 7—*Allotheridion ohlerti* (Thorell), palp, ventral view. 8—*Allotheridion ohlerti* (Thorell), palp, lateral view.

Eularia microtarsus (Emerton), 1882.

Chamberlin & Ivie, 1945b, p. 6, figs. 17-18.
WYO.: TETON PARK: along Snake River near Moran (in wet woods).

Grammonota pictilis (O. P. Cambridge), 1875.

Bishop & Crosby, 1932, p. 406, figs. 33-36, 38-39.
S. DAK.: CUSTER PARK: near Game Lodge.

Islandiana alata (Emerton), 1919.

Holm, 1945, pp. 21-25, figs. 5 a-d.—not *Aduva alata* (Emerton), Bishop & Crosby, 1936, p. 39, figs. 1-3.
WYO.: TETON PARK: Uhl Hill.

Labuella prosaica Chamberlin & Ivie, 1943.

Chamberlin & Ivie, 1943, p. 6, figs. 7, 8 ♀.
WYO.: TETON FOREST: Brooks Mountain ♀.

Lepthyphantes aggressus Chamberlin & Ivie, 1943.

Chamberlin & Ivie, 1943, p. 14, figs. 19-20.
WYO.: YELLOWSTONE: Pebble Creek Camp Ground. TETON PARK: Leigh Lake (lodgepole forest); Signal Mountain (lodgepole forest); Uhl Hill. TETON FOREST: Mt. Baldy (lodgepole forest).

Lepthyphantes chamberlini Schenkel, 1950. ? Text-figs. 4 & 6.

Schenkel, 1950, p. 61, fig. 20.
WYO.: YELLOWSTONE: Mammoth Hot Springs. TETON FOREST: Mt. Baldy.

Lepthyphantes complicata (Emerton), 1882.

Zorsch, 1937, p. 881, figs. 55-57.
WYO.: TETON PARK: Signal Mountain (probably under log in lodgepole forest).

Lepthyphantes furcillifer Chamberlin & Ivie, 1933.

Chamberlin & Ivie, 1933, p. 32, figs. 109-112.
WYO.: TETON PARK: Pilgrim Creek (in forest); Signal Mountain (in lodgepole forest).

Lepthyphantes lamprus Chamberlin, 1920.

Chamberlin, 1920, p. 195, figs. 1, 2.
WYO.: TETON PARK: Signal Mountain (in lodgepole forest).

Lepthyphantes pollicaris Zorsch, 1937.

Zorsch, 1937, p. 897, figs. 91-93 ♂.
L. tamara Chamberlin & Ivie, 1943, p. 15, fig. 23 ♀.
WYO. YELLOWSTONE: Pebble Creek Camp Ground. TETON PARK: Lake Solitude; Blacktail Butte; Uhl Hill. TETON FOREST: Mt. Baldy.

Lepthyphantes rainieri Emerton, 1926.

Zorsch, 1937, p. 895, figs. 83-87.
WYO.: TETON FOREST: Mt. Baldy

Linyphia litigiosa Keyserling, 1886. Text-figs. 2 & 5.

Blauvelt, 1936, p. 107, figs. 21-25.
WYO.: TETON PARK: Garnet Canyon.

Linyphia marginata C. L. Koch, 1834.

Kaston, 1948, p. 122, figs. 220-230, 2004, 2022.
S. DAK.: CUSTER PARK: near Game Lodge.
WYO.: DEVILS TOWER. TETON PARK: Garnet Canyon; Holly Lake. TETON FOREST: Slide Lake. (This spider builds a web in low shrubs).

Microneta fratrella (Chamberlin), 1919.

Chamberlin & Ivie, 1933, p. 35, figs. 61, 93-95, 101-102.
WYO.: TETON PARK: Amphitheater Lake (elev. 9,750 ft.); Cottonwood Creek (river bottom).

Minyrioloides affinis Schenkel, 1929.

Minyriolus aquatilis Crosby & Bishop, 1933, p. 135, figs. 104-109.
WYO.: YELLOWSTONE: Indian Creek.

Pelecopsis sculptum (Emerton), 1917.

Crosby & Bishop, 1931, p. 382, figs. 80-85.
WYO.: TETON PARK: Pilgrim Creek (under drift wood).

Pityohyphantes alticeps Chamberlin & Ivie, 1943.

Chamberlin & Ivie, 1943, p. 27, figs. 45-47.
WYO.: YELLOWSTONE: Mammoth Hot Springs (on low shrubs).

Pityohyphantes cristatus Chamberlin & Ivie, 1942.

Chamberlin & Ivie, 1942, p. 58, figs. 141-143.
WYO.: YELLOWSTONE: Pebble Creek Camp (?). TETON PARK: Garnet Canyon; Leigh Lake (?); Signal Mountain (?); Two Ocean Lake. (This spider builds its web on low shrubs).

Pusillia bonita Chamberlin & Ivie, 1943.

Chamberlin & Ivie, 1943, p. 26, figs. 41, 42.
MONT.: Cooke. WYO.: YELLOWSTONE: Pebble Creek Camp Site (on vegetation in meadow). TETON PARK: Two Ocean Lake; Uhl Hill.

Sciastes terrestris (Emerton), 1882. ?

Bishop & Crosby, 1938, p. 79, figs. 54-56.
WYO.: TETON PARK: Pilgrim Creek

(on stones in creek bed); Cottonwood Creek (in river bottom).

ARGIOPIDAE.
ORB-WEAVERS.

Aculepeira verae Chamberlin & Ivie, 1942. ?

Chamberlin & Ivie, 1942, p. 75, figs. 215-216.

WYO.: YELLOWSTONE: Indian Creek.

Araneus marmoreus Clerck, 1757.

Epeira raji Kaston, 1948, p. 257, figs. 816-848, 820-822.

WYO.: TETON PARK: Moran; Signal Mountain (lodgepole forest, a large orb-web in shrubs or low trees).

Araniella displicata (Hentz), 1847.

Epeira displicata Kaston, 1948, p. 258, fig. 806.

WYO.: TETON PARK: Pilgrim Creek; Emma Matilda Lake; Signal Mountain. (Builds orb-webs in light woods).

Cyclosa conica (Pallas), 1772.

Kaston, 1948, p. 236, figs. 711-713, 2037.

S. DAK.: CUSTER PARK: near Game Lodge (orb-webs on a fence).

WYO.: DEVILS TOWER. YELLOWSTONE: Indian Creek; Mammoth Hot Springs; Pebble Creek; Lewis Lake. TETON PARK: Leigh Lake; Jackson Lake northwest of Moran; Pilgrim Creek; Signal Mountain. (Builds orb-webs in light woods).

Cyclosa turbinata (Walckenaer), 1841.

Kaston, 1948, p. 337, fig. 710.

WYO.: DEVILS TOWER.

Epeira patagiata (Clerck), 1757.

E. dumetorum Kaston, 1948, p. 255, figs. 788, 804, 813.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: TETON PARK: Leigh Lake; Jackson Lake northwest of Moran; Signal Mountain; Moran; Two Ocean Lake. TETON FOREST: Gros Ventre Slide. (The orb webs of this spider were found in forests).

Tetragnatha laboriosa Hentz, 1850.

Kaston, 1948, p. 269, figs. 850-851, 859-861.

WYO.: TETON PARK: Cottonwood Creek; Gros Ventre River; Jackson Lake northwest of Moran; Moran; Pilgrim Creek; Emma Matilda Lake. TETON FOREST: Gros Ventre Slide. (This spider was found in meadows).

Tetragnatha versicolor Walckenaer, 1841.

Kaston, 1948, p. 270, figs. 852, 862-864.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: YELLOWSTONE: Heart Lake. TETON PARK: Amphitheater Lake; Leigh Lake; Cottonwood Creek; Pilgrim Creek; Moran; Gros Ventre River; Jackson Lake northwest of Moran; Two Ocean Lake; Emma Matilda Lake. TETON FOREST: Gros Ventre Slide. (The orb webs of this spider were usually found close to water).

AGELENIDAE.
FUNNEL-WEB WEAVERS.

Agelenopsis utahana (Chamberlin & Ivie), 1933.

Chamberlin & Ivie, 1941, p. 600, figs. 12, 23, 38.

WYO.: TETON PARK: Garnet Canyon; Leigh Lake; Signal Mountain; Two Ocean Lake; Emma Matilda Lake; Moran. (The funnel webs of this spider were usually found in shrubs in forests).

Circurina robusta Simon, 1886.

Chamberlin & Ivie, 1940, p. 68, figs. 53, 87.

WYO.: YELLOWSTONE: Pebble Creek Camp Ground. TETON PARK: Signal Mountain.

LYCOSIDAE.
WOLF SPIDERS.

Arctosa alpigena (Doleschal), 1852.
Text-figs. 9 & 20.

Dahl & Dahl, 1927, pp. 67-68, figs. 174-176.

WYO.: YELLOWSTONE: Indian Creek Camp Ground (in lodgepole forest); Pebble Creek Camp Ground. TETON PARK: Amphitheater Lake (elev. 9,750 ft.). TETON FOREST: Brooks Mountain (elev. 10,300 ft., at timberline); Mt. Baldy.

Arctosa rubicunda (Keyserling), 1876.

Kaston, 1948, p. 319, figs. 1044-1046.

S. DAK.: CUSTER PARK: near Game Lodge.

Lycosa frondicola Emerton, 1885.

Kaston, 1948, p. 328, figs. 1110-1113.

WYO.: TETON PARK: Pilgrim Creek.

Lycosa pratensis Emerton, 1885.

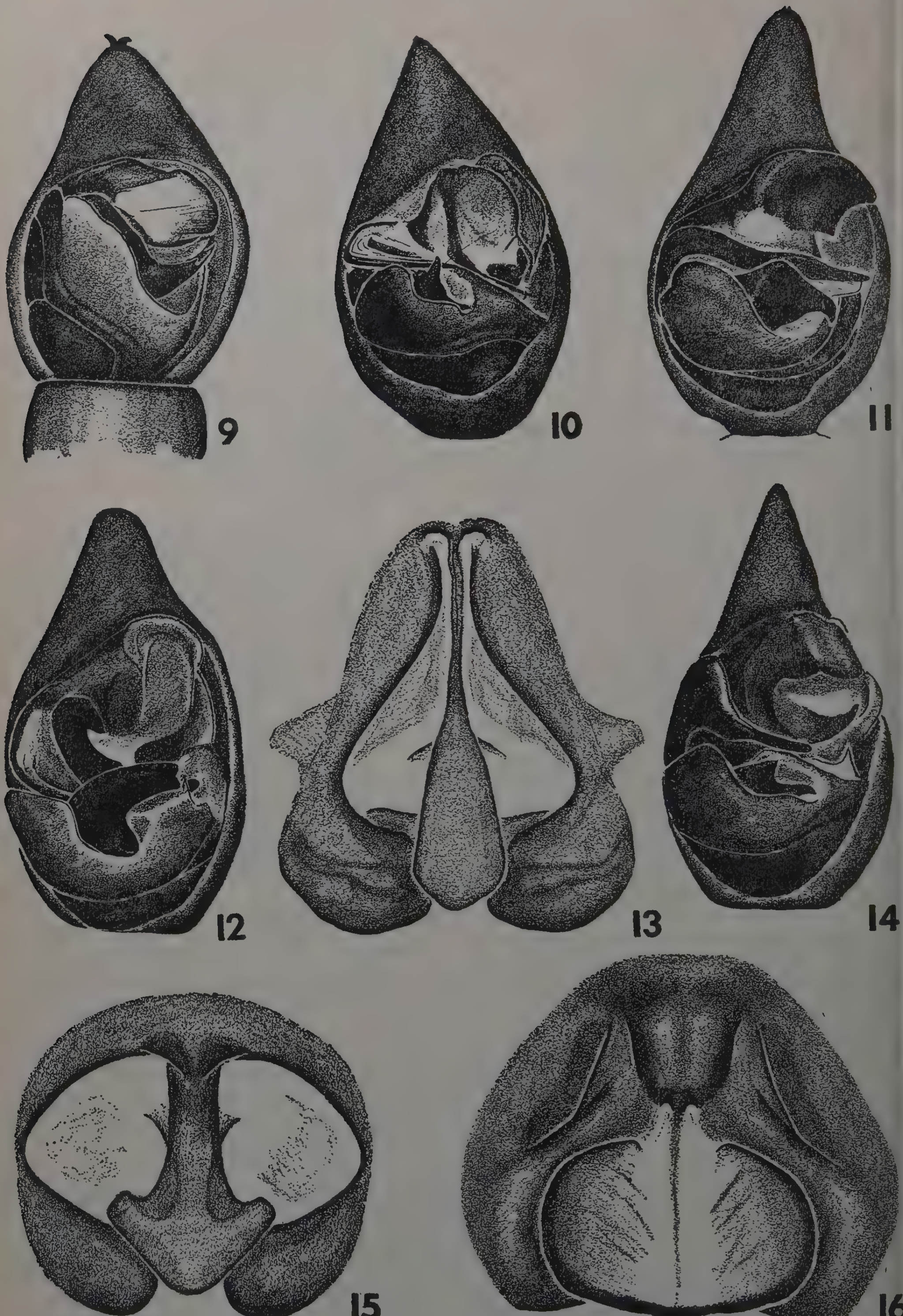
Trochosa pratensis Kaston, 1948, p. 330, figs. 1092-1094, 1117-1118.

WYO.: TETON PARK: Death Canyon (elev. 8,300 ft., running between rocks); Signal Mountain; Cottonwood Creek.

Pardosa anomala Gertsch, 1933.
Text-fig. 10.

Gertsch, 1933a, p. 26, fig. 36 ♀.

Coloration of the male like that of the female; the structure likewise resembles that of the female. The palps are densely covered by black hair. It is illustrated by Text-fig. 10. Male allotype from Death Canyon.



TEXT-FIGS. 9-16. 9—*Arctosa alpigena* (Doleschal), palp, ventral view. 10—*Pardosa anomala* Gertsch, palp, ventral view. 11—*Pardosa solituda*, n. sp., palp, ventral view. 12—*Pardosa fuscula* (Thorell), palp, ventral view. 13—*Pardosa groenlandica* (Thorell), epigynum. 14—*Pardosa groenlandica* (Thorell), palp, ventral view. 15—*Pardosa fuscula* (Thorell), epigynum (specimen from Wisc.). 16—*Pardosa solituda*, n. sp., epigynum.

WYO.: TETON PARK: Death Canyon (elev. 8,300 ft. ♀♀♂ among rocks); Lake Solitude (elev. 9,024 ft., among rocks); Cascade Canyon (elev. 7,500 ft., in forest floor). TETON FOREST: Brooks Mountains ♀♀♂♂. SHOSHONE NATIONAL FOREST: Sublet Lake♀♂.

Pardosa coloradensis Banks, 1894.

P. sternalis Chamberlin, 1908, p. 185 (in part) pl. 14. fig. 2 ♀.

P. ontariensis Gertsch, 1933a, p. 18, fig. 27 ♂.

WYO.: YELLOWSTONE: Indian Creek Camp Ground. TETON PARK: Moran (running near bldgs.); Blacktail Butte.

Pardosa concinna (Thorell), 1877.

P. muscicola Emerton, 1911, p. 401, pl. 5. fig. 2.

WYO.: YELLOWSTONE: Indian Creek Camp Ground (in meadow).

Pardosa distincta (Blackwall), 1846.

Kaston, 1948, p. 333, figs. 1095-1099, 1119-1121.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: TETON PARK: Moran; Uhl Hill.

Pardosa fuscula (Thorell), 1875.
Text-figs. 12 & 15.

Lycosa fuscula Thorell, 1875, p. 501.

S. DAK.: CUSTER PARK: near Game Lodge.

Pardosa groenlandica (Thorell), 1872.
Text-figs. 13 & 14.

Lycosa groenlandica Thorell, 1872, p. 157.

WYO.: YELLOWSTONE: summit of Mt. Washburn, shore of Heart Lake. TETON PARK: Lake Solitude (elev. 9,024 ft.); Holly Lake (9,400 ft.); Amphitheater Lake (9,750 ft.); Garnet Canyon (9,000 ft.); Leigh Lake (6,870 ft.); Jackson Lake north of Moran (6,750 ft.). (This spider was collected running over stones, either the pebbles of a lake shore or boulders in alpine surroundings).

Pardosa lapidicina Emerton, 1885.

Kaston, 1948, p. 337, figs. 1129, 1143-1145, 2068.

WYO.: TETON PARK: Pilgrim Creek (under driftwood).

Pardosa mackenziana (Keyserling), 1876.

Kaston, 1948, p. 338, figs. 1133-1136.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: Very common in all parts of YELLOWSTONE and TETON PARK in which collections were made. It was found running on the ground in many habitats.

Pardosa moesta Banks, 1892.

Kaston, 1948, p. 334, figs. 1122, 1123, 1137.

S. DAK.: CUSTER PARK: near Game Lodge.

MONT.: Cooke.

WYO.: TETON PARK: Two Ocean Lake (in an aspen grove).

Pardosa sternalis (Thorell), 1877.

Chamberlin, 1908, p. 185-188, pl. 63. figs. 5-6.

P. altamontis Chamberlin & Ivie, 1946, pp. 7-8. figs. 7-8 ♀.

WYO.: YELLOWSTONE: Heart Lake Geyser Basin (on surfaces of pools). TETON PARK: Two Ocean Lake; Signal Mountain Lake (on lake shore); Cottonwood Creek; Moran (between buildings near water); Gros Ventre River near highway 287 (sides of stream bed). TETON FOREST: Brooks Mountain (in pine and spruce forest).

Pardosa tetonensis Gertsch, 1933.

Gertsch, 1933a, p. 19, figs. 28, 38.

MONT.: Cooke.

WYO.: YELLOWSTONE: Indian Creek Camp Ground (in meadow). TETON PARK: shore of Jackson Lake northwest of Moran.

Pardosa uintana Gertsch, 1933.

P. uncata Emerton, 1894, (in part), pp. 425-426, pl. 3. figs. 8c, 8d, 8f.

WYO.: TETON FOREST: Brooks Mountain.

Pardosa utahensis Chamberlin, 1919.

Gertsch & Wallace, 1935, figs. 3, 7.

WYO.: TETON PARK: Blacktail Butte. TETON FOREST: Gros Ventre Slide.

Pardosa xerampelina (Keyserling), 1876.

Kaston, 1948, p. 337, figs. 1130-1132, 1146.

S. DAK.: CUSTER PARK: near Game Lodge.

MONT.: Cooke.

WYO.: YELLOWSTONE: Indian Creek.

Pardosa solituda, n. sp.
Text-figs. 11 & 16.

Color: Carapace a rich dark brown; eye region blackish, with no distinct markings. Clypeus and chelicerae lighter brown, with distal part of mesal border of chelicerae yellowish. Labium and endites a dusky orange, lighter at the tips. Sternum brown. Coxae dusky orange. Legs and palpi: dark brown without distinct markings. Abdomen: dorsum dark gray with a brown anterior lanceolate mark, venter brown. Spinnerets dark gray. Female lighter in color and less red.

Structure: Essentially typical, similar to *Pardosa groenlandica* (Thorell) from which it differs in the structure of the epigynum

and palpus. Anterior eye row shorter than the middle row, which in turn is shorter than the third row. Anterior row very slightly procurved; anterior median eyes about two-thirds their diameter apart and a little more than their radius from the smaller side eyes. Middle eyes slightly larger than the posterior ones, about one diameter apart and about one and one-half diameters from the hind eyes which are about three and one-half their own diameter from each other.

Measurements	*Male*	*Female*
Total length	9.1 mm.	9.0 mm.
Carapace		
Length	4.5	4.4
Width	3.4	3.4
Tibia-patella		
I	5.2	5.3
IV	5.9	5.9

Records: Male holotype from southeast shore of Lake Solitude (running between stones in meadow), Grand Teton National Park, Wyoming, elev. 9,024 ft., 31 July, 1950. Female allotype from Hidden Lake Camp, Mount Timpanogos, Utah County, Utah, elev. 9,700 ft., 31 Aug., 1939 (Amer. Mus. Nat. Hist. Coll.).

Pirata insularis Emerton, 1885.

Kaston, 1948, p. 310, figs. 987-988, 1005, 1011.

WYO.: TETON PARK: Moran (between buildings, near water).

Pirata piratica (Clerck), 1757.

Kaston, 1948, p. 309, figs. 1003, 1010.

S. DAK.: CUSTER PARK: near Game Lodge (around backwaters of Grace Coolidge Creek).

WYO.: TETON PARK: Moose ponds.

Schizocosa wasatchensis
Chamberlin & Ivie, 1942.
Text-figs. 17 & 18.

Chamberlin & Ivie, 1942, p. 39.

WYO.: TETON PARK: near Phelps Lake (in the shade on trail through a high meadow).

Tarentula aculeata (Clerck), 1757.

Kaston, 1948, p. 312, figs. 1024-1025, 2139-2140.

MONT.: Cooke.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: DEVILS TOWER. YELLOWSTONE: Indian Creek; Pebble Creek; Heart Lake.

GNAPHOSIDAE.

Callilepis altitudonis Chamberlin, 1936.
Text-fig. 19.

Chamberlin, 1936a, p. 14. fig. 25 ♀.

WYO.: TETON PARK: near Amphitheater Lake (in forest).

Callilepis imbecilla (Keyserling), 1887.

Kaston, 1948, p. 343, figs. 1150-1151, 1158-1159.

S. DAK.: CUSTER PARK: near Game Lodge.

Drassodes neglectus (Keyserling), 1887.

Kaston, 1948, p. 351, figs. 1176, 1188-1189, 1195.

WYO. TETON PARK: Pilgrim Creek (under driftwood); Uhl Hill. TETON FOREST: Gros Ventre Slide.

Gnaphosa brumalis Thorell, 1875.

Kaston, 1948, p. 346, figs. 1156-1157, 1185.

MONT.: Cooke.

WYO.: YELLOWSTONE: Mammoth Hot Springs. TETON FOREST: Brooks Mountain (in pine spruce forest under logs).

Gnaphosa muscorum (L. Koch), 1866.

Kaston, 1948, p. 344, figs. 1152-1155, 1160, 1177.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: TETON PARK: Holly Lake (under a rock); Pilgrim Creek. TETON FOREST: Mt. Baldy.

Gnaphosa parvula Banks, 1896.

Kaston, 1948, p. 346, figs. 1161-1162, 1184.

WYO.: TETON PARK: Signal Mountain Emma Matilda Lake (on ground in sagebrush).

Haplodrassus signifer (C. L. Koch), 1839.

Kaston, 1948, p. 350, figs. 1170-1172, 1186.

WYO.: TETON PARK: Signal Mountain (on lodgepole forest floor).

Orodrassus coloradensis (Emerton), 1877.

Drassodes melius Chamberlin, 1919, p. 246, figs. 4, 5.

Orodrassus coloradensis Chamberlin, 1936b, p. 7, fig. 23 ♀.

WYO.: TETON PARK: Death Canyon (elev. 7,600 ft., in forest); Leigh Lake; shore of Jackson Lake northwest of Moran (lodgepole forest); Pilgrim Creek; Moran; Two Ocean Lake (aspen grove); Uhl Hill. (Usually found under logs or rocks).

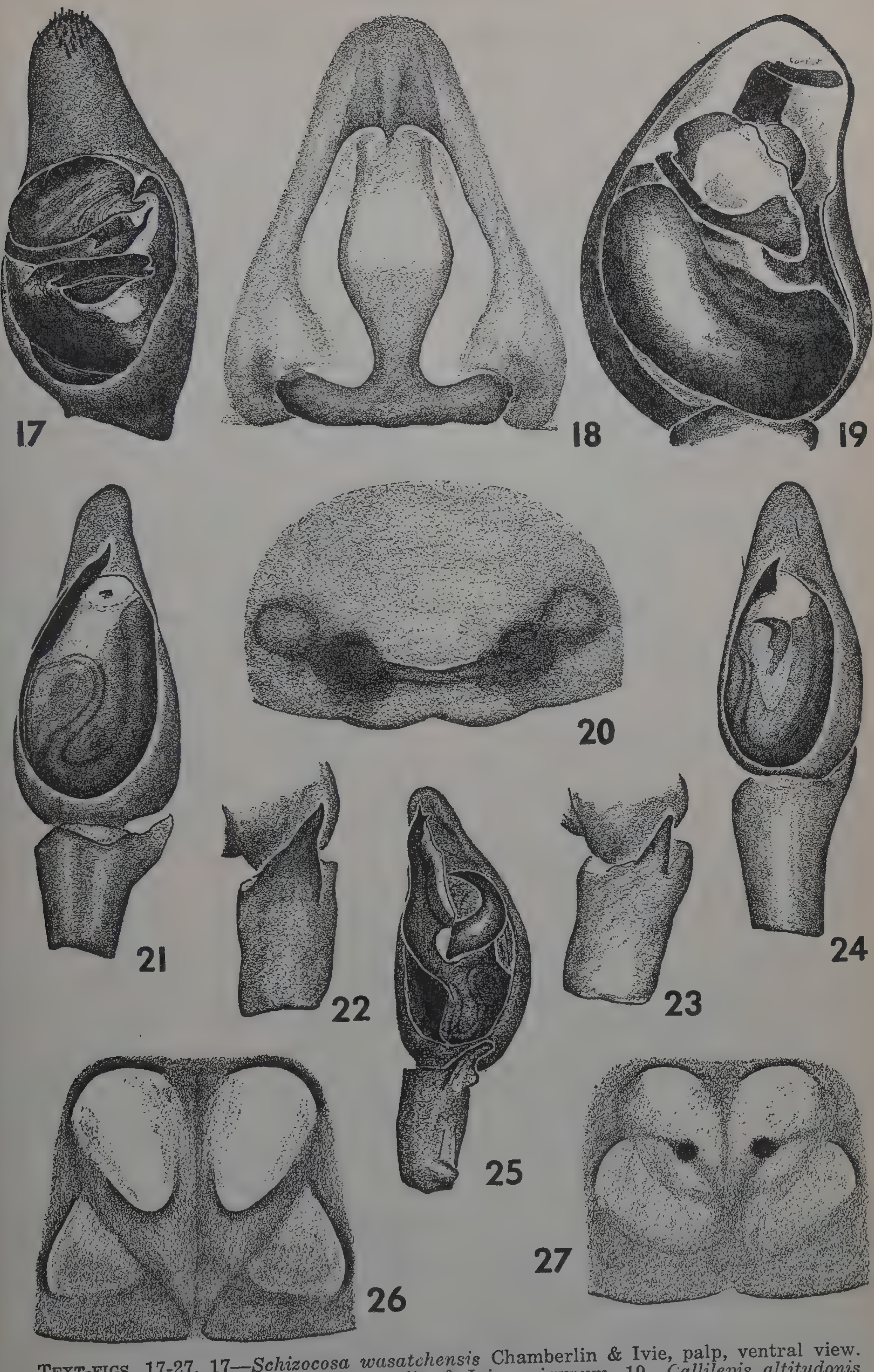
Poecilochroa montana Emerton, 1890.

Emerton, 1890, p. 175, pl. 4, fig. 2.

WYO.: YELLOWSTONE: Mammoth Hot Springs.

Zelotes puritanus Chamberlin, 1922.

Kaston, 1948, p. 356, figs. 1239-1241.



TEXT-FIGS. 17-27. 17—*Schizocosa wasatchensis* Chamberlin & Ivie, palp, ventral view. 18—*Schizocosa wasatchensis* Chamberlin & Ivie, epigynum. 19—*Callilepis altitudonis* Chamberlin, palp, ventral view. 20—*Arctosa alpigena* (Doleschal), epigynum. 21—*Micaria tetonia*, n. sp., palp, ventral view. 22—*Micaria tetonia*, n. sp., tibia of palp, lateral view. 23—*Micaria coloradensis* Banks, tibia of palp, lateral view. 24—*Micaria coloradensis* Banks, palp, ventral view. 25—*Anyphaena pacifica* (Banks), palp, ventral view. 26—*Micaria jacksonia*, n. sp., epigynum. 27—*Micaria coloradensis* Banks, epigynum.

WYO.: YELLOWSTONE: Indian Creek Camp Ground (in meadow). TETON PARK: Pilgrim Creek (under driftwood); Blacktail Butte.

Zelotes subterraneus (C. L. Koch), 1839.

Kaston, 1948, p. 356, figs. 1248-1251.

WYO.: YELLOWSTONE: Indian Creek; Heart Lake. TETON PARK: Amphitheater Lake (elev. 9,750 ft.); Lake Solitude (9,024 ft.); Jackson Lake NW of Moran; Pilgrim Creek; Signal Mountain (lodgepole forest); Blacktail Butte. (Usually found under rocks or logs).

CLUBIONIDAE.

Anyphaena pacifica (Banks), 1896.
Text-fig. 25.

Bryant, 1931, p. 115, fig. 36 ♀.

S. DAK.: CUSTER PARK: near Game Lodge.

Clubiona canadensis Emerton, 1890.

Kaston, 1948, p. 376, figs. 1288-1290, 1344-1346.

WYO.: TETON PARK: Death Canyon (abundant under rocks in meadow near snow); Leigh Lake; Two Ocean Lake (lodgepole forest); Cottonwood Creek (under stones in river bottom).

Clubiona kulczynskii de Lessert, 1905.

C. intermontana Gertsch, 1933b, p. 9, figs. 10-13 ♂.

C. intermontana Gertsch, 1941b, p. 17, fig. 49 ♀.

WYO.: TETON PARK: Emma Matilda Lake (in lodgepole forest); Two Ocean Lake (lodgepole forest).

Micaria altana Gertsch, 1933.

Gertsch, 1933b, p. 6, fig. 5 ♀.

Gertsch, 1935, p. 17, fig. 38 ♂.

WYO.: YELLOWSTONE: Indian Creek (in meadow). TETON PARK: Two Ocean Lake (in lodgepole forest). TETON FOREST: Gros Ventre Slide. (Usually found under logs, stones or running over the ground).

Micaria coloradensis Banks, 1896.
Text-figs. 23, 24 & 27.

Banks, 1896, p. 58.

WYO.: TETON PARK: Moran; (D. C. Lowrie).

Micaria hesperella Gertsch & Jellison, 1939.

Micaria constricta Emerton, 1894, p. 414, pl. 2. fig. 5.

M. canadensis Roewer, 1951, p. 446.

WYO.: TETON PARK: Amphitheater Lake; Garnet Canyon (in talus); Lake Solitude. (Found underneath or running over rocks).

Micaria jacksonia, n. sp.
Text-fig. 26.

Color: Female: Carapace dark brown, heavily mottled with black, and clothed with white scales. Sternum, endites and labium very dark brown. Coxae and femora dark brown; distal segments of legs orange; femora covered with white and black scales; abdomen gray, covered with dark iridescent scales except for a median lighter chevron pointing forward, and two anterior lighter areas, one on each side. The two areas as well as parts of the chevron covered with white scales. Venter lighter gray, with some light colored scales just behind and around the epigynum.

Structure: Female: Similar to *M. montana* Emerton, 1890; however, the carapace is narrower, particularly in the head region. Carapace widest between the second and third coxae and if examined from the side, highest near the third coxa, and sloping slightly towards the eye region. Clypeus as wide as the diameter of an anterior lateral eye. Anterior median eyes are slightly smaller than the anterior laterals and about equal to posterior laterals. Both eye rows are procurved. Anterior medians are about their diameter apart, and less than a third their diameter from the laterals. The oval posterior medians separated by two long diameters from each other and by one and a half from the laterals. Anterior and posterior laterals are separated by a diameter of the former. Median ocular quadangle longer than broad and about as wide in front as behind. Abdomen elongate oval without any constrictions. Epigynum is illustrated by Text-fig. 26.

Measurements	*Female*	
Total length	4.50 mm.	
Carapace		
Length	1.40	
Width	1.05	
Sternum		
Length	.86	
Width	.67	
First leg		Fourth leg
Femur	1.10 mm.	1.40 mm.
Patella	.48	.54
Tibia	.83	1.10
Metatarsus	.64	1.10
Tarsus	.80	.80
Total length	3.85 mm.	4.94 mm.

Records: Female holotype from shore of Jackson Lake, several miles northwest of Moran, Grand Teton National Park, Wyo., 3 Aug., 1950.

Micaria tetonia, n. sp.
Text-figs. 21 & 22.

Color: Male: Carapace brown with gray mottling and gray dots. Some white scales cover the carapace. Sternum, endites and labium brown; legs yellow, the first two femora slightly darker. Legs covered with

dark scales. Abdomen dark brown covered with iridescent dark scales, venter of the abdomen lighter brown covered with some iridescent scales. There are no light marks on the abdomen.

Structure: Male: Carapace very wide posteriorly, narrowing abruptly in the head region above and anterior to the first coxae. Carapace widest between the third and fourth coxae and if examined from the side, highest between the third and fourth coxae and sloping very slightly toward the eye region. Clypeus as high as a diameter and a half of the anterior lateral eyes. Anterior median eyes smallest, somewhat smaller than the posterior laterals. The longer diameter of the oval posterior medians is subequal to the diameter of the anterior laterals. Anterior laterals appear to be the largest. Both eye rows procurved. Anterior medians are about a diameter and a half apart and almost touch the laterals. Posterior laterals one of their diameters from the posterior medians and a diameter and a half from the anterior laterals. Posterior medians a little more than their diameter apart. Median ocular quadrangle slightly longer than wide and somewhat wider behind than in front. Abdomen not constricted. This species can readily be told from other members of the genus by the structure of the palp.

Measurements	*Male*	
Total length	3.40 mm.	
Carapace		
Length	1.50	
Width	1.20	
Sternum		
Length	.87	
Width	.75	
First leg		Fourth leg
Femur	1.30 mm.	1.40 mm.
Patella	.58	.57
Tibia	.96	1.30
Metatarsus	.80	1.30
Tarsus	.80	1.02
Total	4.44 mm.	5.59 mm.

Record: Male holotype from lodgepole forest along foot trail to summit of Signal Mountain, Moran, Grand Teton National Park, Wyo., July, 1950.

Phrurotimpus borealis (Emerton), 1911.

Kaston, 1948, p. 389, figs. 1356, 1385-1386.

S. DAK.: CUSTER PARK: near Game Lodge.

Phrurotimpus certus Gertsch, 1941.

Gertsch, 1941a, p. 17, figs. 47-48.

WYO.: DEVILS TOWER.

Scotinella custeri, n. sp.

Text-fig. 28.

Color: Female: Integument of carapace light yellowish-brown, with some irregular gray maculations. On the sides these maculations increase to form a gray line. Sternum, endites, labium and legs yellowish-brown. Abdomen dark gray above with a wide white chevron pointing anteriorly near the middle, and some very fine indistinct chevrons or lines posterior. Venter of abdomen much lighter, light gray anterior to the spinnerets, and nearly white behind the epigynum.

Structure: Female: Probably close to *S. connectus* (Gertsch), 1941. Clypeus equals in height the diameter of the anterior median eyes, Anterior row of eyes procurved, second row nearly straight. Anterior median eyes separated by one-half their diameter and nearly touching the anterior laterals. Posterior medians separated by their radius and by that same distance from the posterior laterals. Median ocular quadrangle slightly longer than wide, and slightly narrower in front. Anterior median eyes smaller than the anterior laterals which are subequal in size to the eyes of the posterior row. Chelicerae slightly geniculate. The epigynum is illustrated by Text-fig. 28.

Measurements	*Female*	
Total length	2.15 mm.	
Carapace		
Length	.85	
Width	.61	
Sternum		
Length	.48	
Width	.45	
First leg		Fourth leg
Femur	.55 mm.	.58 mm.
Patella	.25	.24
Tibia	.59	.58
Metatarsus	.48	.61
Tarsus	.32	.48
Total length	2.19 mm.	2.49 mm.

Records: Female holotype and paratype from Custer State Park near Game Lodge, Custer County, South Dakota, 20 June, 1950.

Scotinella pelvicolens

(Chamberlin & Gertsch), 1930.

Phruronellus pelvicolens Chamberlin & Gertsch, 1930, p. 138, figs. 6-8.

WYO.: TETON PARK: Uhl Hill.

THOMISIDAE.

Crab spiders.

Coriarachne utahensis (Gertsch), 1932.

Platyxysticus utahensis Gertsch, 1932, p. 5, fig. 2.

WYO.: YELLOWSTONE: Indian Creek (forest). TETON PARK: along Snake River near Moran (in wet woods under bark).

Ebo sp.

WYO.: TETON PARK: Uhl Hill.

Misumena vatia (Clerck), 1757.

Kaston, 1948, p. 411, figs. 1481-1482, 1496-1498.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: YELLOWSTONE: Pebble Creek; Signal Mountain; Moran. (Found sitting on flowers).

Oxyptila nevadensis Keyserling, 1880.

Gertsch, 1939, p. 347, figs. 112, 113, 132.

S. DAK.: CUSTER PARK: near Game Lodge.

Philodromus alascensis Keyserling, 1884.
Text-figs. 33 & 34.

Keyserling, 1884, p. 674, pl. 21, fig. 22.

WYO.: TETON PARK: Lake Solitude (9,024 ft.); Garnet Canyon (9,000 ft., on talus); Moran.

UTAH: Wasatch National Forest: Farmington Canyon in Davis Co.

Philodromus aureolus (Clerck), 1757.

Kaston, 1948, p. 436, figs. 1557-1559.

WYO.: TETON PARK: in wet woods along Snake River near Moran.

Philodromus speciosus Gertsch, 1934.
Text-fig. 31.

Gertsch, 1934a, p. 22, figs. 21, 23 ♂.

UTAH: Dixon National Forest: Vermilion Castle.

Philodromus virescens Thorell, 1877.
Text-figs. 29 & 30.

Thorell, 1877, p. 500.

WYO.: TETON FOREST: Uhl Hill.

Philodromus wyomingensis Gertsch, 1934.

Gertsch, 1934a, p. 18, fig. 17 ♂.

WYO.: YELLOWSTONE: Pebble Creek Camp.

Thanatus altimontis Gertsch, 1933.

Gertsch, 1933a, p. 6, figs. 2, 48.

WYO.: TETON PARK: Blacktail Butte.

Thanatus formicinus (Clerck), 1757.

Kaston, 1948, p. 438, figs. 1592-1594.

S. DAK.: CUSTER PARK: near Game Lodge.

Tibellus parallelus (C. L. Koch), 1837.

T. oblongus Kaston, 1948, p. 440, figs. 1607-1608, 1616, 2008.

WYO.: YELLOWSTONE: Pebble Creek Camp Ground (in meadow on vegetation); TETON PARK: Jackson Lake northwest of Moran (on sagebrush).

Xysticus benefactor Keyserling, 1880.

Gertsch, 1939, p. 399, figs. 246, 247, 260.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: YELLOWSTONE: Indian Creek (meadow); TETON PARK: Jackson Lake northwest of Moran (on sagebrush).

Xysticus cunctator Thorell, 1877.

Gertsch, 1939, p. 390, figs. 222, 223, 226, 234 and 235.

WYO.: TETON PARK: Blacktail Butte.

Xysticus emertoni Keyserling, 1880.

Gertsch, 1939, p. 374, figs. 158, 159, 197.

MONT.: Cooke.

WYO.: TETON PARK: Two Ocean Lake (in lodgepole forest).

Xysticus lutulentus Gertsch, 1934.

Gertsch, 1939, p. 396, figs. 242, 243, 262.

WYO.: TETON PARK: Pilgrim Creek; Two Ocean Lake (in aspen grove).

Xysticus triguttatus Keyserling, 1880.

Gertsch, 1939, p. 362, figs. 169, 178, 179.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: DEVILS TOWER.

SALTICIDAE.

Jumping Spiders.

Evarcha hoyi (Peckham), 1883.

Kaston, 1948, p. 469, figs. 1713-1717, 2134-2136.

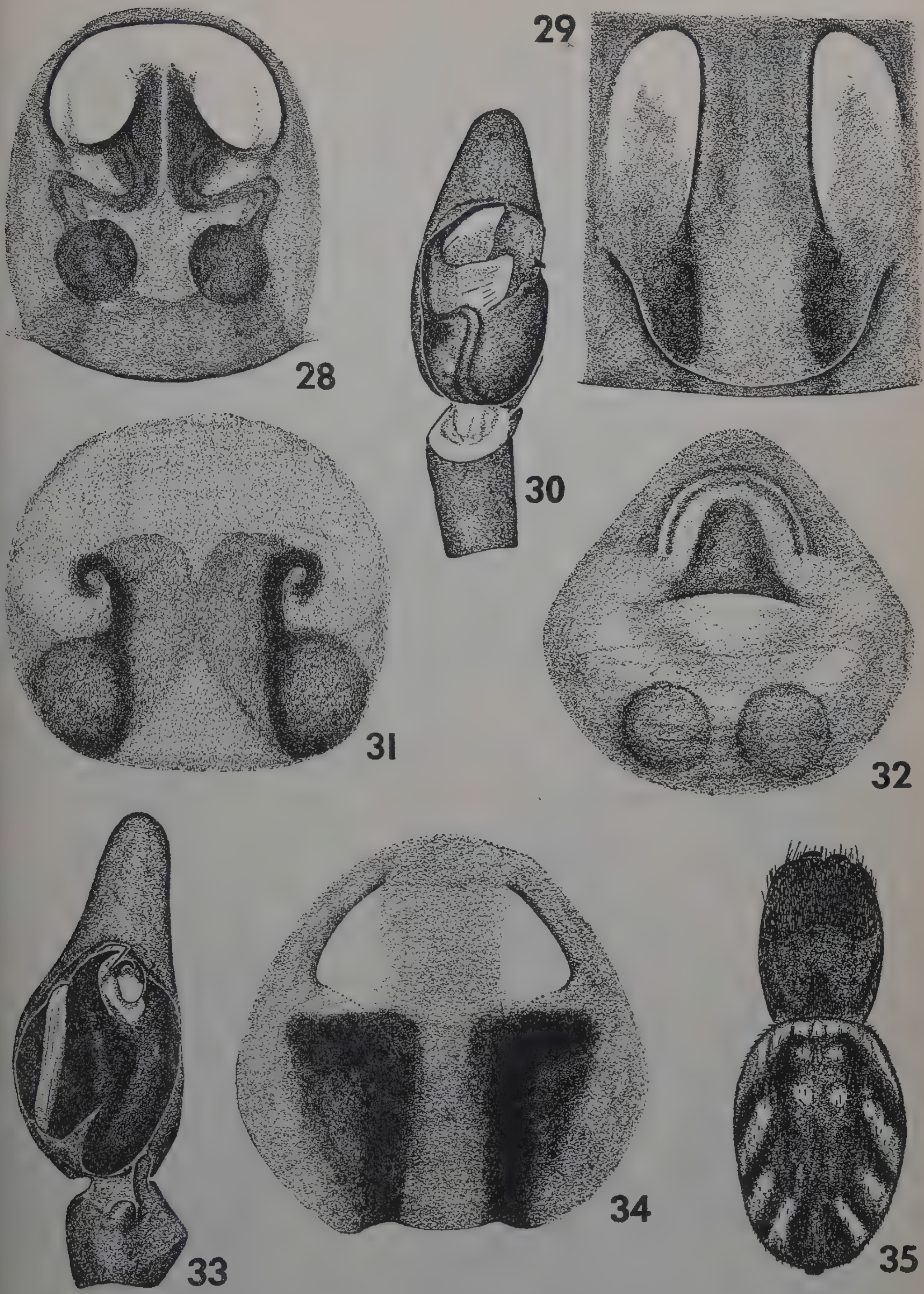
S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: TETON PARK: Signal Mountain (in lodgepole forest).

Habronattus altanus (Gertsch), 1934.
Text-figs. 32 & 35.

Pellenes altanus Gertsch, 1934b, p. 21, fig. 21 ♂.

Female: Integument of the carapace brown except for the area between the eyes, which is black. Light brown scales and black hairs cover the area of the carapace above. On each side appears a band lacking light brown scales, and another of equal width below along the margin with white or light brown scales. Chelicerae light brown. Labium, endites, sternum and coxae yellowish-brown, covered with some white and black hairs. Legs light brown with some irregular darker mottling covered in part by white scales. Integument of abdomen dark brown except for light areas shown in Text-fig. 35. Venter light yellowish-brown except for the faint indications of three longitudinal darker bands. Area around spinnerets darker. Dorsum, sides and area around spinnerets cov-



TEXT-FIGS. 28-35. 28—*Scotinella custeri*, n. sp., epigynum. 29—*Philodromus virescens* Thorell, epigynum. 30—*Philodromus virescens* Thorell, palp, ventral view (specimen from Calif.). 31—*Philodromus speciosus* Gertsch, epigynum. 32—*Habronattus altanus* (Gertsch), epigynum. 33—*Philodromus alascensis* Keyserling, palp, ventral view. 34—*Philodromus alascensis* Keyserling, epigynum. 35—*Habronattus altanus* (Gertsch), dorsal view of female.

ered by scales which are colored light brown above and grade into white scales above the lighter dorsal areas and on the sides. The structure is typical.

A male and female collected together at Gothic, Gunnison County, Colorado. Summer, 1947 (elev. 9,000 ft.).

WYO.: TETON PARK: Amphitheater Lake (elev. 9,750 ft.).

Habronattus americanus (Keyserling), 1885.

Pellenes americanus Peckham & Peckham, 1909, p. 537, pl. 46, fig. 6.

WYO.: TETON PARK: shore of Jackson Lake northwest of Moran.

Habronattus brunneus (Peckham), 1901.

Pellenes brunneus Peckham & Peckham, 1909, p. 542, pl. 44, fig. 8, pl. 45, fig. 4.

WYO.: TETON PARK: Pilgrim Creek (on stones of riverbed).

Habronattus philipi
(Gertsch & Jellison), 1939.

Pellenes philipi Gertsch & Jellison, 1939, p. 12, figs. 1, 2.

WYO.: TETON PARK: Garnet Canyon (elev. 9,000 ft., on talus).

Icius similis Banks, 1895.

Kaston, 1948, p. 489, figs. 1812-1813, 1838-1840.

S. DAK.: CUSTER PARK: near Game Lodge.

Metaphidippus clematus, n. sp.
Text-figs. 37, 39, 40 & 42.

Color: Male: Carapace rich dark brown, eyes on black patches. On each side of the carapace is a band of white scales. Above the anterior median eyes are some white scales. Clypeus brown. Chelicerae, sternum and legs brown. Legs covered with white hair and some white scales. Abdomen brown with a marginal band of white scales on each side. Some males show four pairs of darker spots on the abdomen similar to those of the female. Venter of abdomen lighter brown.

Female: Color in general very light. Carapace brown; the eyes are on black patches. Carapace covered with white scales. Clypeus densely covered with white scales. Chelicerae brown, sternum and legs yellow brown. Legs and palps covered with white hairs. Abdomen light yellowish-white with four pairs of more or less distinct spots which may be absent or appear just as darker maculations. Abdomen is covered with white scales and some long dark hairs, except in the region of the spots where there are no scales. Venter of the abdomen light and covered with white scales and hairs.

Structure: Typical. The male is similar to *M. montanus* (Emerton), 1891, but can be differentiated by the different structure of the embolus of the palpal organ. (Text-fig. 42).

The epigynum resembles *M. protervus* (Walckenaer), 1837, and appears to vary considerably in shape in different individuals examined.

Measurements	*Male*	*Female*
Total length	4.2 mm.	5.0 mm.
Carapace		
Length	1.8	2.1
Width	1.5	1.7
Tibia-patella		
I	1.5	1.5
IV	1.3	1.6

Records: Male holotype and female allotype and male and female paratypes from Medicine Hat, Alberta, in the collection of the American Museum of Natural History. A male specimen from Mammoth Hot Springs, Yellowstone National Park, Wyoming, collected 28 June, 1950; another from Gros Ventre Slide, Teton National Forest, Wyoming, 26 July, 1950.

Pellenes lagganii Peckham & Peckham, 1909.
Text-figs. 47 & 49.

Peckham & Peckham, 1909, p. 560, pl. 49, fig. 2 ♂.

WYO.: YELLOWSTONE PARK: Indian Creek (on forest floor). TETON PARK: in wet forest along Snake River near Moran.

Phidippus altanus Gertsch, 1934.
Text-figs. 48 & 50.

Gertsch, 1934b, p. 12, fig. 13 ♂.

WYO.: TETON PARK: wet woods along Snake River near Moran (abundant under bark of some standing dead trees).

Phidippus johnsonii Peckham, 1883.

Peckham & Peckham, 1909, p. 404, pl. 31, fig. 1.

WYO.: TETON PARK: Holly Lake (elev. 9,400 ft., among rocks); Pilgrim Creek; Blacktail Butte.

Sitticus finschii (L. Koch), 1879.
Text-figs. 38, 41 & 44.

Attus finschii L. Koch, 1879, p. 489, fig. 4.

WYO.: YELLOWSTONE: Indian Creek.

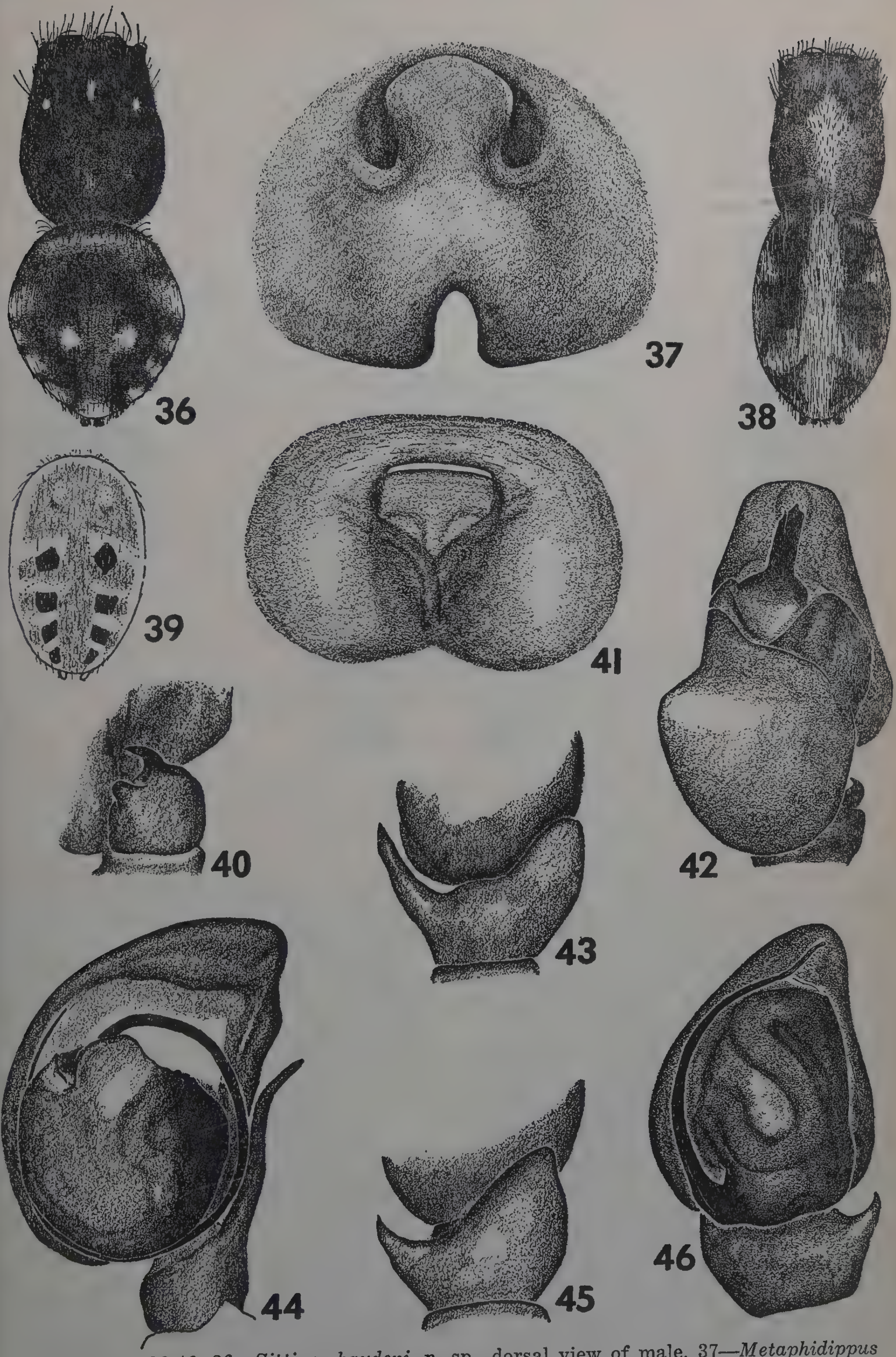
Sitticus ranieri Peckham & Peckham, 1909.
Text-fig. 43

Peckham & Peckham, 1909, p. 520, pl. 43, fig. 5.

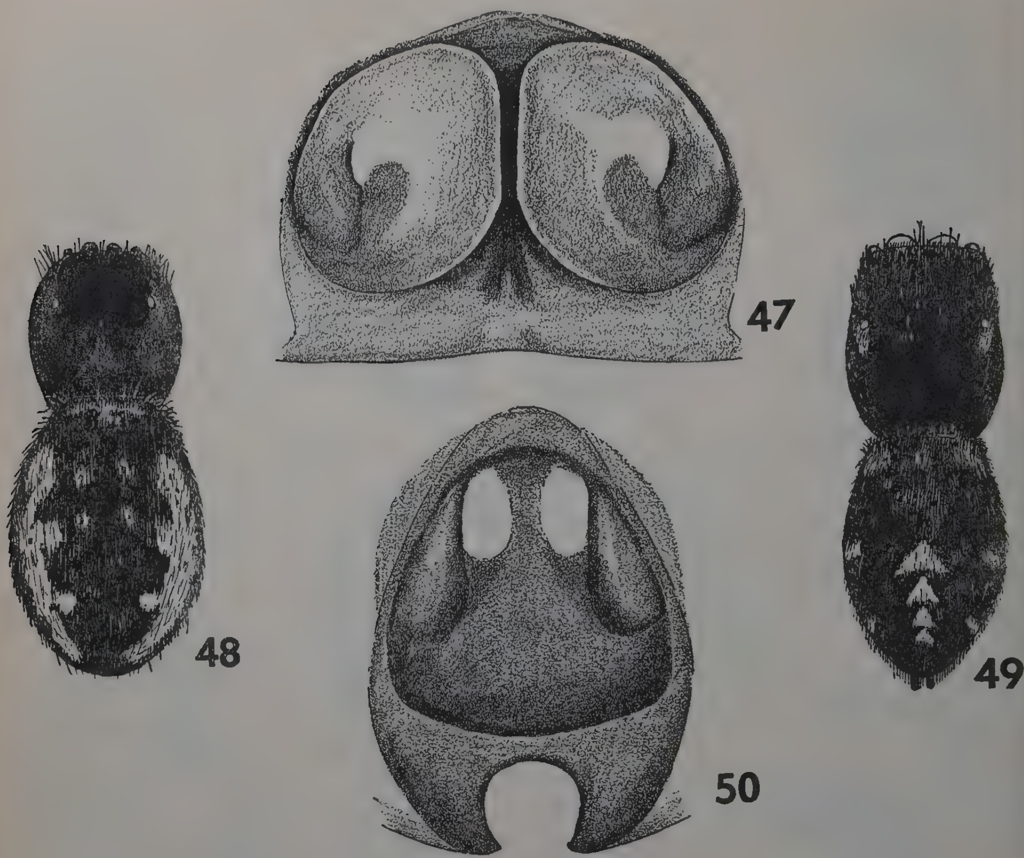
WYO.: YELLOWSTONE: Mammoth Hot Springs. TETON PARK: Holly Lake (elev. 9,400 ft., among rocks).

Sitticus haydeni, n. sp.
Text-figs. 36, 45 & 46.

Color: Male: Carapace dark brown, eye



TEXT-FIGS. 36-46. 36—*Sitticus haydeni*, n. sp., dorsal view of male. 37—*Metaphidippus clematus*, n. sp., epigyum. 38—*Sitticus finschii* (L. Koch), dorsal view of male. 39—*Metaphidippus clematus*, n. sp., abdomen of female, dorsal view. 40—*Metaphidippus clematus*, n. sp., tibia of palps, lateral view. 41—*Sitticus finschii* (L. Koch), epigynum (specimen from Alberta). 42—*Metaphidippus clematus*, n. sp., palp, ventral view. 43—*Sitticus ranieri* Peckham & Peckham, tibia of palp, dorsal view. 44—*Sitticus finschii* (L. Koch), palp, ventral view. 45—*Sitticus haydeni*, n. sp., tibia of palp, dorsal view. 46—*Sitticus haydeni*, n. sp., palp, ventral view.



TEXT-FIGS. 47-50. 47—*Pellenes lagganii* Peckham & Peckham, epigynum. 48—*Phidippus altanus* Gertsch, dorsal view of female. 49—*Pellenes lagganii* Peckham & Peckham, dorsal view of female. 50—*Phidippus altanus* Gertsch, epigynum.

region black, with some white and some iridescent reddish scales and black hairs above the black area and scattered white scales behind. A distinct patch of white scales between posterior median eyes. Clypeus covered with white scales. Chelicerae brown, sternum dark brown and coxae lighter brown. Sternum and coxae covered by white hair. Legs brown with some dark maculations covered with many black hairs and white scales. Abdomen dark brown above, and covered by white and iridescent reddish and black scales. The dorsum has two indistinct longitudinal bands of black scales on which are a pair of large, white spots. Between the dark bands is a band of white, black and red scales; outside of the dark bands, a band of white and reddish scales which continues as a transverse band anteriorly. This band is interrupted posteriorly by some indistinct white spots. (See Text-fig. 36) Venter lighter brown, covered with white and red scales.

Structure: Carapace fairly high, flattened above, the sides abruptly declining. Eyes of the first row slightly recurved. Small eyes of the second row nearer the eyes of the third row. Posterior eye row as wide as the first. Quadrangle of eyes occupying 5/13 of the carapace. In general this species is very similar in both markings and structure to *S. ranieri* Peckham, but can be differentiated from this species by the shorter tibial apophysis of the palp. (Text-fig. 45).

Measurements	*Male*
Total length	4.5 mm.
Carapace	
Length	2.2
Width	1.7
Tibia-Patella	
I	1.3
IV	2.1

Records: Male holotype was collected in Yellowstone National Park, July, 1931, by W. E. Gertsch.

Talavera minuta Banks, 1895.

Kaston, 1948, p. 470, figs. 1738-1739.

WYO.: TETON PARK: Amphitheater Lake (elev. 9,750 ft.).

DICTYNIDAE.

Callobius nomeus (Chamberlin), 1919.

Amaurobius nomeus Chamberlin, 1947b, p. 48, figs. 11, 18.

WYO.: TETON PARK: Leigh Lake; Signal Mountain; Two Ocean Lake. TETON FOREST: Mt. Baldy. (Found on the underside of logs in forests).

Dictyna alaskae Chamberlin & Ivie, 1947.

Chamberlin & Ivie, 1947a, p. 13-14, figs. 2, 3.

MONT.: Cooke.

Dictyna annulipes Blackwall, 1846.

D. muraria Kaston, 1948, p. 506, figs. 1893, 1919-1926, 2073-2074.

WYO.: TETON PARK: in wet woods along Snake River near Moran (on vegetation); Two Ocean Lake (lodgepole forest, on vegetation). TETON FOREST: Gros Ventre Slide.

Dictyna borealis O. P. Cambridge, 1872.

Dictyna cavernosa Jones, 1947, p. 12, figs. 28-30.

WYO.: TETON PARK: Moran; Jackson Lake northwest of Moran.

Dictyna cruciata Emerton, 1888.

Kaston, 1948, p. 508, figs. 1896, 1934-1936.

WYO.: TETON FOREST: Gros Ventre Slide.

Dictyna major Menge, 1869.

D. vincens Chamberlin, 1919, p. 243, figs. 1, 2.

MONT.: Cooke.

WYO.: TETON PARK: Leigh Lake; Moran (on vegetation in aspen grove and in wet forest along Snake River); Two Ocean Lake (on vegetation in lodgepole forest and in aspen groves); Emma Matilda Lake (on sagebrush); Jackson Lake northwest of Moran (on sagebrush); Signal Mountain (lodgepole forest). TETON FOREST: Mt. Baldy; Togwotee Pass; Gros Ventre Slide.

UTAH: Wasatch National Forest: Farmington Canyon in Davis Co.

Dictyna phylax Gertsch & Ivie, 1936.

Gertsch & Ivie, 1936, p. 7, figs. 29-30.

WYO.: YELLOWSTONE: Indian Creek. TETON PARK: Leigh Lake; Signal Mountain; Moran; Emma Matilda Lake (in lodgepole forest).

Dictyna quadrispinosa Emerton, 1919.

Emerton, 1919, p. 106, fig. 5.

S. DAK.: CUSTER PARK: near Game Lodge.

Dictyna tridentata Bishop & Ruderman, 1946.

Bishop & Ruderman, 1946, p. 2, figs. 3-4.

WYO.: TETON PARK: Leigh Lake.

Dictyna uintana Chamberlin, 1919.

Chamberlin, 1919, p. 240, figs. 3-5.

WYO.: TETON PARK: Emma Matilda Lake (on vegetation in lodgepole forest).

Titanoeca americana Emerton, 1888.

Kaston, 1948, p. 578, figs. 1970, 1997-2003.

S. DAK.: CUSTER PARK: near Game Lodge.

WYO.: TETON PARK: Signal Mountain (in lodgepole forest).

Tricholathys spiralis Chamberlin & Ivie, 1935.

Chamberlin & Ivie, 1935, p. 28, figs. 21, 99, 100-105.

WYO.: TETON FOREST: Gros Ventre Slide.

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18.

A Spontaneous Epithelioma in the Platyfish, *Xiphophorus (Platypoecilus) variatus.*[1]

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(Plates I & II; Text-figures 1 & 2).

Introduction.

Schlumberger & Lucké (1948), in a review of tumors in cold-blooded vertebrates, reported that papillomas and epitheliomas have been found in a variety of marine and freshwater fishes from different parts of the world. The epitheliomas are of special interest since they show various degrees of malignancy and possess a pattern of growth and histological structure somewhat similar to those found in man (Ewing, 1949; Willis, 1948), in other mammals (Feldman, 1932) and in lower vertebrates.

The present paper is concerned with a description of a single case of a spontaneous epithelioma or epidermoid carcinoma in a laboratory-reared platyfish, *Xiphophorus (Platypoecilus) variatus*. This is the first such case to be reported in the Order Cyprinodontiformes, or killifishes. (The visceral epithelioma described by Raabe, 1939, in *Mollienisia* is not comparable to the tumor in *Xiphophorus*).

Description.

The epithelioma developed on the dorsolateral surface of the head, immediately above the operculum, in an adult female specimen measuring 36.25 mm. in standard length and 11.00 mm. in depth. (Text-figs. 1 & 2). The fish was obtained from a laboratory colony the original stock of which was collected in a pool near El Nilo, San Luis Potosi, Mexico, in 1940. Since 1940 hundreds of members of this species, representing 10 generations, were reared, but only one specimen was found (in 1951) with a tumor of this kind.

The tumor measured 5.25 mm. in length, 5.00 mm. in width and 5.25 mm. in height. When first observed, the growth was quite large, smooth, pinkish and sharply circumscribed. After several weeks it developed into a highly vascular nodular structure which hemorrhaged freely when the fish was handled. When the fish became moribund, it was sacrificed. The parts associated with the tumor were fixed in Bouin's fluid and decalcified in nitric acid and phloroglucin. Paraffin sections were cut at 5 microns and stained with Delafield's hematoxylin-eosin or with Masson's trichrome stain.

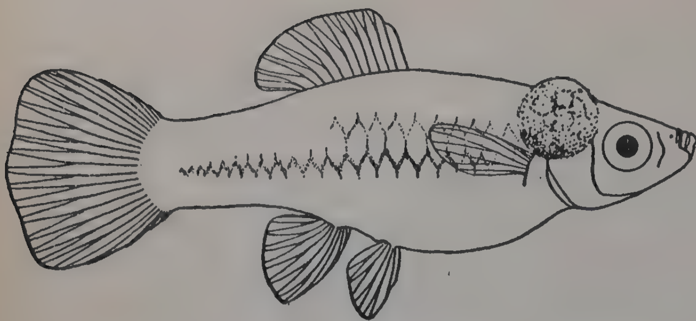
Histologically, the main portion of the tumor was subepidermal and in some regions distinct from the surface epidermis (Pl. I, fig. 1). The epidermis was somewhat thickened but otherwise normal. It contained typical epithelial cells which were interspersed with round and clavate mucus cells. Micromelanophores were numerous at the junction of the epidermis and the subepidermal region. A few were seen scattered in the body of the tumor.

The growth was composed primarily of clusters of small epithelial cells supported by a delicate connective tissue reticulum. No mucus cells, characteristic of the surface epidermis, were found in this region. Although numerous capillaries were present there was only a mild inflammatory reaction as evidenced by the presence of a few macrophages and other leucocytes localized in certain peripheral areas of the growth. Cells somewhat similar to those identified in normal tissues in other fish species by Duthie (1939) and Catton (1951) as coarse granulocytes in the discharging state were seen scattered in the connective tissue in regions below the epidermis (Pl. II, fig. 5). These cells were oval or pear-shaped; the former measured about 8 × 4 microns and contained club-shaped inclusions which stained red with Masson's method. The function of these cells, if they are the same as those described by the above investigators, has not been definitely established. Catton (1951) "proposed that the 'granules' are in reality vesicles with fluid contents, which are ultimately discharged at epithelial surfaces."

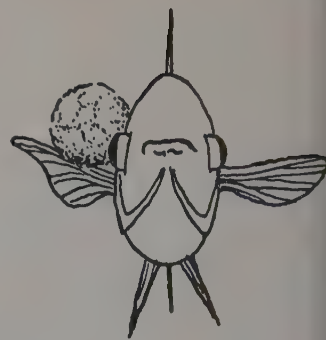
The epithelial elements of the tumor were small cells of various shapes with scanty cytoplasm and with nuclei that appeared normal. Mitotic stages were frequently encountered. Occasionally, concentric groups of these cells were flattened by pressure which apparently produced pearl-like structures (Pl. I, fig. 2). No cornification occurred,

[1] Supported by a grant from the National Cancer Institute, National Institutes of Health, Public Health Service.

[2] From the Genetics Laboratory of the New York Zoological Society at the American Museum of Natural History, New York 24, N. Y.



TEXT-FIG. 1. Lateral view of the *Xiphophorus* (*Platypoecilus*) *variatus* female, showing the extent of the spontaneous epithelioma which developed above the operculum. The surface of the tumor was nodular and vascular. 3×.



TEXT-FIG. 2. Frontal view of the *Xiphophorus* (*Platypoecilus*) *variatus* female, showing the spherical outline of spontaneous epithelioma, 3×.

however, since the epithelium of the skin of fishes does not form keratin. In some areas a few large binucleate and multinucleate cells with distinct pale-staining vesicular nuclei containing one or more nucleoli were present (Pl. I, fig. 3). These might be syncytial cells, which are sometimes seen in certain tumor processes.

Some evidence of malignancy was found in the tumor. The cells had completely replaced the original corial tissue, and in the posterior part of the growth they had penetrated the limiting membranes and invaded the muscle tissue near the operculum (Pl. II, fig. 4). The muscle fibers in this region were disoriented and hyalinized. No evidence of metastasis was found. From this evidence, it seems appropriate to classify this tumor as a malignant non-metastatic epidermoid carcinoma.

In the course of the examination of the other organs and tissues of the body, it was found that, in addition to the epithelioma, the fish had an enlarged thyroid which was similar in histological structure to the thyroid tumors reported in a related species, *Xiphophorus montezumae*, by Gorbman & Gordon (1951). The presence of two distinct types of tumors at the same time is exceptionally rare in fish and in other animals. (Two kinds of pigment cell tumors were described recently in a group of genetically related fishes by Nigrelli, Jakowska & Gordon, 1951). In the present case there was no apparent relationship between the thyroid tumor and the epithelioma.

DISCUSSION.

Schlumberger & Lucké (1948) revealed considerable confusion in published reports concerning the differentiation of papillomas and epitheliomas in fishes. In their review on this subject they had placed certain tumors which were described "as epitheliomas under the heading of papilloma because of their structure and absence of invasion." It should be indicated, however, that fish tumors grow very slowly and it is not always possible to differentiate these two types of growths on the basis of invasiveness. In this connection, Willis (1948) stated that in humans, "Epidermoid carcinomas of the skin differ widely in their invasiveness. Many of them are of relatively low malignancy, growing and penetrating the underlying tissues only slowly; and no sharp distinction between papillomas and these chronic carcinomas can be made." This statement may also apply to similar tumors in the skin of fishes.

SUMMARY.

A spontaneous, malignant, non-metastatic epithelioma (epidermoid carcinoma) was found in the head region of a laboratory-bred female platyfish, *Xiphophorus* (*Platypoecilus*) *variatus*. The tumor was similar in many respects to the skin epitheliomas of mammals and other vertebrates. This is the first case of such a tumor from a fish belonging to the Order Cyprinodontiformes.

ACKNOWLEDGEMENTS.

The authors thank Dr. William N. Tavolga and Mr. James W. Atz for reading the manuscript, Mr. Donn E. Rosen for drawing the text-figures, and the American Museum of Natural History for laboratory facilities.

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EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Cross-section of the *Xiphophorus* (*Platypoecilus*) *variatus* female at the level of the gills. The extent of the spontaneous epithelioma can be seen to the left. At this level no invasion of the underlying musculature can be seen. Magnification approximately 18×.

Fig. 2. Section through the anterior portion of the epithelioma. A metaphase plate can be seen in the center of the field. Magnification approximately 600×.

Fig. 3. Section through the center of the epithelioma, showing a multinucleate giant cell upper right, and an incipient pearl formation lower right. Magnification approximately 600×.

Plate II.

Fig. 4. Posterior portion of the epithelioma. The center of the field shows muscle fibers surrounded and separated by invading epithelioma cells. Magnification approximately 280×.

Fig. 5. Lateral portion of the epithelioma just below the epidermal covering, showing the cells described by Catton (1951) as coarse granulocytes in a discharging state. The cells can be recognized by their club-shaped inclusions. The vesicle usually seen at the blunter end of the cell cannot be seen in these preparations. Magnification approximately 1050×.

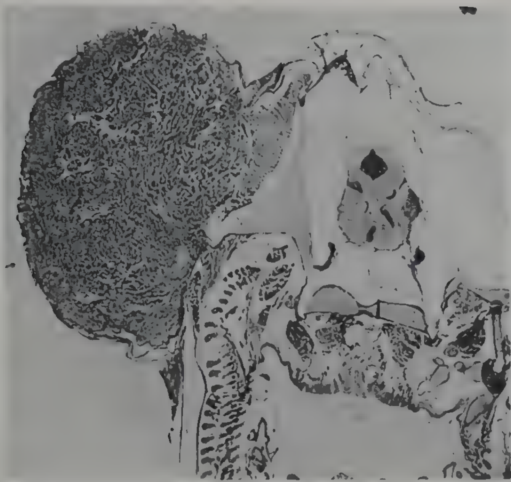

FIG. 1.

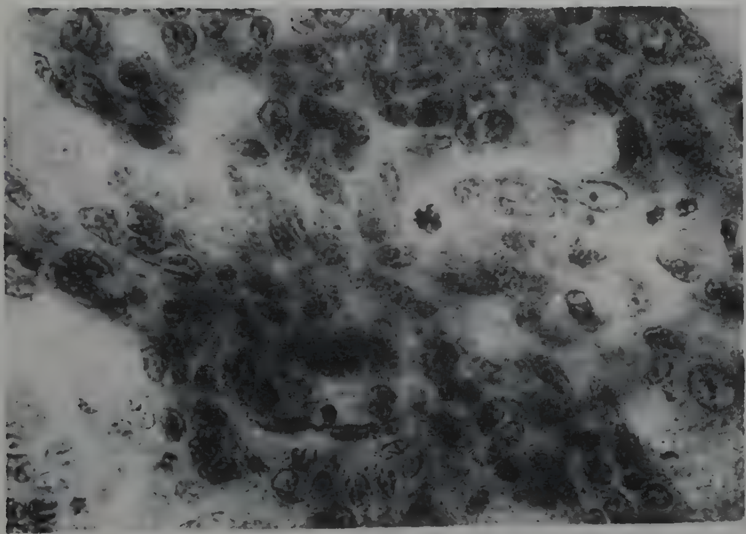

FIG. 2.

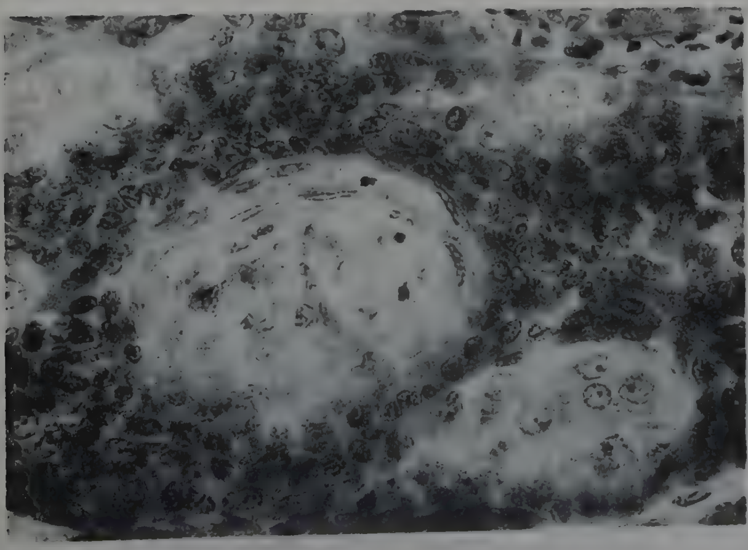

FIG. 3.

A SPONTANEOUS EPITHELIOMA IN THE PLATYFISH, XIPHOPHORUS (PLATYPOECILUS) VARIATUS.

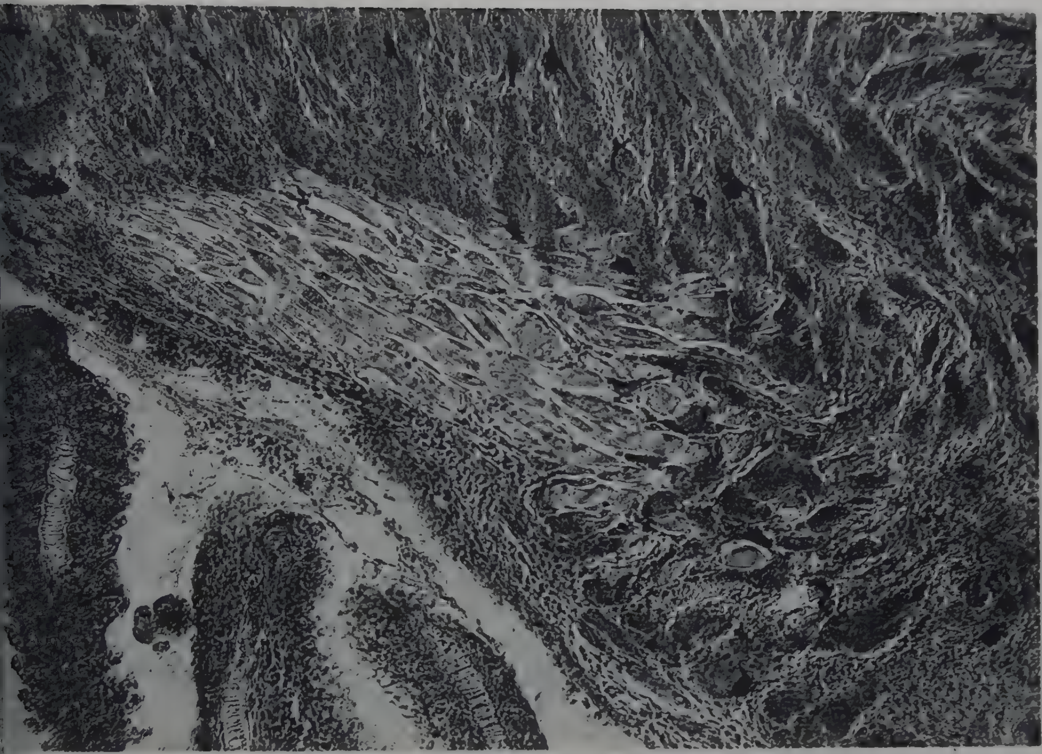

FIG. 4.

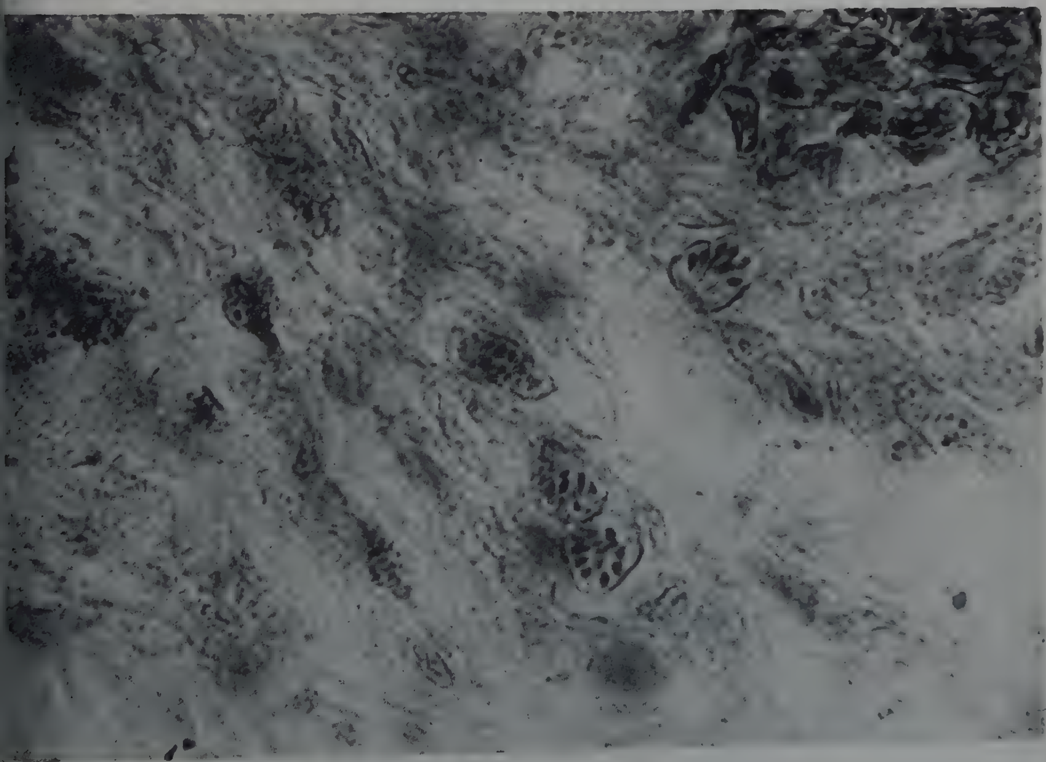

FIG. 5.

A SPONTANEOUS EPITHELIOMA IN THE PLATYFISH, XIPHOPHORUS (PLATYPOECILUS) VARIATUS.

19.

Migration of Day-flying Moths Through Portachuelo Pass, Rancho Grande, North-central Venezuela.[1]

WILLIAM BEEBE & HENRY FLEMING.
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(Plate I).

[This is one of a series of papers resulting from the 45th, 46th and 47th Expeditions of the Department of Tropical Research of the New York Zoological Society, made during 1945, 1946 and 1948, under the direction of Dr. William Beebe, with headquarters at Rancho Grande in the National Park of Aragua, Venezuela. The expeditions were made possible through the generous cooperation of the National Government of Venezuela and of the Creole Petroleum Corporation.

[The characteristics of the research area are in brief as follows: Rancho Grande is located in north-central Venezuela (10° 21′ N. Lat., 67° 41′ W. Long.), 80 kilometers west of Caracas, at an elevation of 1,100 meters in the undisturbed montane rain forest which covers this part of the Caribbean range of the Andes. The migration flyway of Portachuelo Pass, which is also the water-shed between the Caribbean and Lake Valencia, is 200 meters from Rancho Grande. Adjacent ecological zones include seasonal forest, savanna, thorn woodland, cactus scrub, the fresh-water lake of Valencia and various marine littoral zones. The Rancho Grande area is generally subtropical, being uniformly cool and damp throughout the year because of the prevalence of the mountain cloudcap. The dry season extends from January into April. The average humidity during the expeditions, including parts of both wet and dry seasons, was 92.4%; the average temperature during the same period was 18° C.; the average rainfall over a five-year period was 174 cm. The flora is marked by an abundance of mosses, ferns and epiphytes of many kinds, as well as a few gigantic trees. For further details see Beebe & Crane, *Zoologica*, Vol. 32, No. 5, 1947. Unless otherwise stated, the specimens discussed in the present paper were taken in the montane cloud forest zone, within a radius of one kilometer of Rancho Grande.

[For an account of Portachuelo Pass, together with a general introduction to the groups of migrating insects and migrating factors, see "Insect Migration at Rancho Grande," by William Beebe, *Zoologica*, 1949, Vol. 34, No. 12, pp. 107-110. Papers dealing with specific groups are as follows; Papilionidae (Vol. 34, No. 14, pp. 119-126); Danaidae, Ithomiidae, Acraeidae and Heliconidae (Vol. 35, No. 3, pp. 57-68); Pieridae (Vol. 35, No. 16, pp. 189-196); Nymphalidae, Brassolidae, Morphidae, Libytheidae, Satyridae, Riodinidae, Lycaenidae and Hesperiidae (Vol. 36, No. 1, pp. 1-16].

MIGRATION OF DAY-FLYING MOTHS.

In our early activities at Portachuelo Pass we thought of this mass emigration, from north to south, as essentially one of butterflies. From the first day onward, however, we saw and captured moths, passing in full sunshine. Thus began our record of diurnal moths. Towards dark these, like the butterflies, would disappear, their place gradually being taken by hosts of nocturnal moths, flying south through the night. These took the same route as the diurnal insects, but thousands upon thousands were deflected to our electric lights on the roof of Rancho Grande, some hundred yards to the east of the southern slope of the pass.

On July 21, 1948, I wrote that "day-flying moths appeared at 7.30 A.M. Today they had everything against them. The first few dozen, of several species, formed an irregular line in midair, then were scattered by the wind. Little by little, hundreds came up the valley, fluttering slowly but steadily until they reached the first gusts. One group after another was forced back. Many took shelter under or on leaves but soon took to wing again. None seemed to give up. Behind them, down the valley, was sun and only a slight breeze; far ahead were the same conditions down the southern slope. In the narrow pass neblina was forming, swirling and vanishing and the cool wind never ceased. A bush would be covered with one or two hundred of a dozen or more species. Then they would start again. Those which succeeded in surmounting the pass formed a narrow, scattered line, which could be seen well down the valley, all still headed swiftly for some unknown goal. In number of individuals laying eggs on capture, these moths equalled the butterflies. After dark not one joined the often congeneric hosts which fluttered about the electric lights."

This quotation could well apply to many other days of migration.

The efficiency of mimicry, in pattern, color and flight, at least to human eyes, was daily manifest. We constantly confused *Pericopis* with ithomiid *Tithorea* and *Melinaea; Pseudomennis, Polypaetes* and *Coreura* masqueraded, to our vision, as riodinid *Mesene,*

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1 Contribution No. 909, Department of Tropical Research, New York Zoological Society.

Baeotis and *Lymnas*. *Eudolophasia* appeared at times indistinguishable from the nymphalid *Phyciodes*.

We caught species after species of Euchromidae under the illusion that we were taking Diptera, Coleoptera or Hymenoptera.

Looking at the collection of day-flying moths as a whole we are struck with their relatively small size and the fact that almost all are clad in distinct, contrasting pattern and colors, and not the subdued hues which, for the most part, characterize small nocturnal species.

For ease of reference and other reasons it has seemed better in the present paper to arrange the sequence of families in the Macrolepidoptera and again in the Microlepidoptera in alphabetical order, and the same applies to the genera in each family.

The day-flying moths which we took number 20 families and 126 species. As in former papers dealing with this migration, I must re-emphasize the exceedingly small number, taken or observed, of these moths, compared with the myriads which eluded our utmost efforts, or which must have passed quite unseen.

The senior author is responsible for the field data and notes, the junior author for the taxonomic identifications. For additional help in this naming we express our gratitude to Doctors William D. Field, John G. F. Franclemont, Hahn W. Capps and J. F. Gates Clarke of the United States National Museum, and to Dr. D. S. Fletcher of the British Museum of Natural History.

NOTE: Under "*Record*," the first figure in parentheses refers to the number of specimens taken, and the figures following the comma are the catalog number or numbers.

MACROLEPIDOPTERA.

ARCTIIDAE.

Belemnia sp. nov., near **alpha** (Druce).

Species Range: Panama and Costa Rica.

Field Characters: This species is impossible to distinguish on the wing from many wasplike euchromids.

Number: Total and taken, 1.

Date: July 21.

Record: 1948—July 21 (1,481296).

Calidota gigas (Dogn.).

Species Range: Panama, Ecuador and Peru.

Field Characters: This large, dark arctiid was taken only once, but five others passed at the same time. Wing span three inches.

Number: Total, 6. Taken, 1.

Record: 1948—May 26 (1 taken, 48632; 5 seen).

Utetheisa o. ornatrix (Linn.).

Species Range: Kansas, West Indies, to southern South America.

Subspecies Range: Same, but not West Indies.

Field Characters: Seen now and then in small or large flocks. 385 counted on July 13, fluttering slowly through the pass, almost a pure culture. At other times seen with other small moths. Like our northeastern species but much paler, with white replacing scarlet on hind wings.

Number: Total, 413. Taken, 6.

Date: June 26 to July 21.

Record: 1948—June 26 (2,48977; 10 seen); July 13 (2,481155; 385 seen), 21 (2 taken; 12 seen).

DIOPTIDAE.

Brachyglene caenea (Drury), form **dilatata** Hering.

Species Range: Mexico, Venezuela and Brazil.

Form Range: Valencia, Venezuela.

Field Characters: Only once were these moths seen in numbers, on May 25.

Number: Total, many. Taken, 3.

Date: May 25 to July 13.

Record: 1948—May 25 (1 taken from flocks); July 8 (1), 13 (1).

Brachyglene subtilis (Felder).

Species Range: Colombia.

Field Characters: On June 7 these moths appeared at 8 A.M. and came through the pass faster and faster, until at least five thousand had passed.

Number: Total, 5,000 plus. Taken, 6.

Date: April 29 to August 7.

Record: 1946—June 7 (3,46544, several thousand passed); August 1 (1 taken; 294 on leaves and flying), 7 (1,461161, several thousand passed). 1948—April 29 (1,48430; 3 seen).

Josia aurifusa Walker.

Species Range: Panama, Colombia, Venezuela and Brazil.

Field Characters: This species is fairly close to *ligata*, but was never taken on the same days. When flying close at hand it was clearly distinguishable.

Number: Total, 409. Taken, 22.

Date: April 29 to July 26.

Record: 1948—April 29 (1,48430); May 23 (1), 26 (1 taken, 13 seen), 29 (55 seen); June 6 (2; 28 seen); July 2 (2; 114 seen), 3 (1; 33 seen), 13 (1; 9 seen), 16 (1; 6 seen), 17 (1,48825; 23 seen), 20 (5 taken), 21 (5 taken; 106 seen), 26 (1 taken).

Josia flavissima (Walker).

Species Range: Colombia, Venezuela and Ecuador.

Field Characters: In flight close to the geometrid *Atyriodes jalapae* but much yellower, and larger in size. No large flocks, and often singly with other insects.

Number: Total, 253. Taken, 39.

Date: April 12 to August 2.

Record: 1948—April 12 (1,48367), 27 (1,48419A; 7 seen), 30 (1; 20 seen); May 21

(1), 23 (1), 25 (3; many found), 26 (2), 29 (3); June 6 (2), 15 (1), 18 (1; 17 seen), 21 (1; 2 seen), 23 (1; 11 seen); July 2 (1; 24 seen), 3 (3; 6 seen), 4 (1; 27 seen), 6 (3; 72 seen), 8 (1; 18 seen), 20 (3), 21 (7; 20 seen), 26 (1); August 2 (1).

Josia ligata Walker.

Species Range: Guatemala, Colombia, Ecuador and Guiana.
Field Characters: Less abundant than *aurifusa* and in smaller flocks.
Number: Total, 71. Taken, 8.
Date: April 15 to July 21.
Record: 1948—April 15 (1, 48368; 33 seen); May 1 (1); July 4 (1; 30 seen), 15 (2), 16 (1), 20 (1), 21 (1).

Phanoptis fatidica (Dogn.).

Species Range: Venezuela to Peru.
Field Characters: To be confused only with the euchromid, *Coreura interposita*, but when flocks did appear they seemed pure cultures of the respective species.
Number: Total, 420 plus. Taken, 16.
Date: April 13 to July 23.
Record: 1948—April 13 (2,48364; 41 in flight), 23 (1,48364A; 33 fighting up-wind); May 1 (1,481467); July 5 (1,481069; 48 seen), 6 (2; 54 seen), 9 (1; 22 seen), 13 (4; 100 plus seen), 17 (2 taken, 15th kilometer), 22 (90 seen), 23 (1; 16 seen).

Polypoetes spp.

The geometrid genus *Polypoetes*, or Pearly Undersides, comprises a generous number of migrants. These moths are small, rather nondescript, black or dark brown, usually with a small orange or white dot near the tip of each forewing, and a greater or less amount of central white on the hindwing. This is often pearly blue on the underside and forms an easy field mark of identification in flight.

Owing to the present confused state of the systematics of this genus, we have indicated the ten species only by Roman numerals. In many cases when we caught a single specimen, others were seen passing in rather compact flocks. We could recognize the genus in flight but only rarely individual species. Hence the numbers "seen" are placed only provisionally with the individuals captured at the same day and place.

Polypoetes, species I.

Number: Total, 51. Taken, 8.
Date: April 28 to July 15.
Record: 1948—April 28 (2,48428; 43 seen), 29 (1,481471); May 24 (1), 26 (1 taken); June 17 (1); July 8 (1,481119H), 15 (1).

Polypoetes, species II.

Number: Total, 59. Taken, 15.
Record: 1946—May 21 (1,461519). 1948—May 26 (3); June 6 (4), 17 (1); July 4 (1 taken; 44 seen); August 2 (2), 8 (3,481119D,G, and I).

Polypoetes, species III.

Number: Total, 9. Taken, 3.
Date: May 29 to June 24.
Record: 1948—May 29 (2); June 18 (1,48835; 6 seen).

Polypoetes, species IV.

Number: Total and taken, 1.
Record: 1948—May 2 (1).

Polypoetes, species V.

Number: Total, 70. Taken, 2.
Record: 1948—May 25 (1); June 28 (1 taken; 68 seen).

Polypoetes, species VI.

Number: Total, 42. Taken, 18.
Date: April 30 to July 21.
Record: 1948—April 30 (1,48470); May 1 (2), 25 (2), 26 (1), 29 (2); June 6 (1), 22 (1,48882); July 3 (2), 9 (1 taken; 18 seen), 14 (1 taken; 6 seen), 15 (1), 16 (1), 20 (1), 22 (1).

Polypoetes, species VII.

Number: Total, 7. Taken, 1.
Record: 1948—July 21 (1 taken; 6 seen).

Polypoetes, species VIII.

Number: Total, 26. Taken 4.
Date: May 8 to July 2.
Record: 1948—May 8 (1), 25 (1), 29 (1); July 2 (1 taken; 22 seen).

Polypoetes, species IX.

Number: Total and taken, 3.
Date: May 29 to July 2.
Record: 1948—May 29 (1); June 6 (1); July 2 (1).

Polypoetes, species X.

Number: Total and taken, 1.
Record: 1948—May 1 (1,48478).

Zunacetha annulata (Guérin).

Species Range: Mexico to Colombia, Venezuela and Guiana.
Field Characters: Flocks were seen on several occasions, easily told from other moths by color and extremely slow, fluttering flight.
Number: Total, 3,000 plus. Taken, 18.
Date: July 3 to 21.
Record: 1948—July 3 (1,481026; 12 seen), 8 (2,481119H,N), 13 (3,481154; 250 plus seen), 15 (5; many seen), 16 (4; many seen), 20 (1; several hundred seen), 21 (2; many seen).

EPIPLEMIDAE.

Nedusia mutilaria cuticulata Guenée.

Species Range: Venezuela, Guianas, south Brazil.
Subspecies Range: Venezuela and Surinam.

Field Characters: Represented by a single individual; small, white, and very badly torn.
Number: Total and taken, 1.
Record: 1948—July (1,481098).

ETHMIIDAE.

Ethmia exornata Zeller.

Species Range: West Indies, Cuba and northern South America.
Field Characters: A sudden wave of these little dotted and banded moths filled the pass on May 24, resting on leaves or fluttering southward against a cool wind.
Number: Total, 301. Taken, 1.
Record: 1948—May 24 (1,48620; 300 plus counted).

EUCHROMIDAE.

Agunaix lacrumans Schaus.

Species Range: Colombia, Peru and Bolivia.
Field Characters: Look and fly exactly like small, black-winged Diptera which were also migrating but in very few numbers. Five times I mistook the flies for moths, but the former were usually flying singly, and the moths were low and slow.
Number: Total, 625. Taken, 11.
Date: May 29 to July 21.
Record: 1948—May 29 (1); June 6 (1), 18 (1,48836; 326 seen); July 3 (2,481033; 29 seen), 21 (6 taken; 259 seen).

Amycles tenebrosa Roth.

Species Range: Venezuela.
Field Characters: Taken twice with flies in same net, but the disparity in numbers and flocking makes our sight records fairly accurate.
Number: Total, 30. Taken, 3.
Date: June 22 and July 16.
Record: 1948—June 22 (1,48885); July 16 (2,481224; 27 seen).

Calonotus triplagus Hmps.

Species Range: Amazons.
Number: Total and taken, 1.
Record: 1948—June 9 (1,48777).

Ceramidia zerny Forster.

Species Range: Venezuela.
Field Characters: Resembling fair-sized, black-winged Diptera, but easily told from the smaller species.
Number: Total, 312. Taken, 15.
Date: April 29 to July 22.
Record: 1948—April 29 (1,48465; 18 seen), 30 (1,48466; 11 seen); May 9 (2), 29 (1); June 6 (1); July 2 (1,481010; 6 seen), 16 (1,481224A; 8 seen), 21 (1,481299; 244 seen), 22 (6,481500; 10 seen).

Coreura interposita Hmps.

Species Range: Venezuela.
Field Characters: Not a flocking species. Five specimens had the pale forewing band colored yellow instead of white.
Number: Total, 60. Taken, 15.
Date: April 29 to July 20.
Record: 1948—April 29 (2,481470), 30 (1,48464); May 1 (2,481528, 481531), 21 (2,48365, 481532), 24 (2,48582; 38 seen), 29 (2,481533, 481536); June 5 (1,481535), 6 (1,48718), 24 (1; 7 seen); July 20 (1).

Correbia lycoides (Walker).

Species Range: Mexico to Paraguay, including Cuba, Jamaica and Puerto Rico.
Number: Total and taken, 1.
Record: 1948—April 12 (1).

Correbia rufescens Roth.

Species Range: Venezuela and Colombia.
Field Characters: Unmistakable from its resemblance to a lycid beetle.
Number: Total, 37. Taken, 2.
Date: July 7 and September 8.
Record: 1946—July 7 (1,461108); September 8 (1; 35 seen).

Cosmosoma telephus (Walker).

Species Range: Colombia to Argentina.
Number: Total and taken, 1.
Record: 1948—May 20 (1,48528).

Cosmosoma t. teuthras (Walker).

Species Range: Mexico to Argentina.
Number: Total and taken, 2.
Date: June 6 and July 15.
Record: 1948—June 6 (1,48715); July 15 (1,481182).

Cosmosoma, sp. nov.

Field Characters: Large Amber-winged euchromid.
Record: 1948—July 9 (1,481131).

Ctenuchia cyaniris Hmps.

Species Range: Venezuela and Ecuador.
Number: Total and taken, 1.
Record: 1948—May 8 (1).

Cyanopepla agyrtidia Hmps.

Species Range: Peru and Bolivia.
Number: Total and taken, 3.
Date: May 26 to July 21.
Record: 1946—June 6 (1,461517). 1948—May 26 (1); July 21 (1).

Cyanopepla alonzo (Butler).

Species Range: Venezuela, Colombia, Ecuador, Peru and Bolivia.
Field Characters: One of the most brilliant of the euchromids—pink, scarlet, iridescent green and blue; very conspicuous on wing.
Number: Total and taken, 8.
Date: April 26 to July 21.
Record: 1948—April 26 (1), 29 (1,481-472); May 6 (1); July 15 (1), 16 (1), 21 (3,481293, 481294, 481295).

Cyanopepla micans (H.-S.).

Species Range: Colombia and Venezuela.
Number: Total and taken, 4.
Date: May 2 to July 16.
Record: 1948—May 2 (1,48481), 9 (1), 29 (1,481527); July 16 (1,481226).

Delphyre titilla (Dogn.).

Species Range: Colombia, Ecuador and Peru.
Field Characters: On July 18 there passed around me a flurry of these little moths. We counted 198.
Number: Total, 201. Taken, 3.
Date: May 29 and July 18.
Record: 1946—May 29 (1); July 18 (2,46784; 198 seen).

Euagra cerymica Druce.

Species Range: Ecuador and Paraguay.
Field Characters: On May 26 we counted 31 and must have missed many more.
Number: Total, 35. Taken, 4.
Date: May 26 to July 16.
Record: 1948—May 26 (1,48624; 31 seen); July 15 (2), 16 (1,481225).

Eucereum cimonis Schaus.

Species Range: Costa Rica, Venezuela and Ecuador.
Number: Total and taken, 1.
Record: 1948—July 23 (1,481506).

Eucereum costulatum H.-S.

Species Range: Panama and Venezuela.
Number: Total and taken, 1.
Record: 1948—May 29 (1).

Eupyra distincta Roth.

Species Range: Venezuela.
Field Characters: These many-spotted black moths were easily distinguished from the smaller, banded *Syntomeida melanthus.*
Number: Total, 24. Taken, 7.
Date: April 30 to July 21.
Record: 1948—April 30 (1,48467); July 15 (1,481181), 16 (3,481223; 17 seen), 21 (2,481501).

Gymnelia bricenoi (Roth.).

Species Range: Venezuela.
Field Characters: Bee-like, flight direct, and identifiable except against bright sky.
Number: Total, 65. Taken, 4.
Date: July 2 to July 13.
Record: 1948—July 2 (1,481009), 4 (1 taken; 39 seen), 13 (1 taken; 22 seen), 16 (1,481226).

Gymnelia flavitarsa (Walker).

Species Range: Colombia, Venezuela and Brazil.
Field Characters: These amber-winged bee mimics, flew straight and swift, usually one at a time, day after day through the pass. Hundreds more too high to be sure of the species, but great numbers certainly took part in this mass migration. On July 18 eight came through, in single file, so that if within reach, a single sweep of the net would have captured all.
Number: Total, 66 counted, 100's seen. Taken, 6.
Date: July 8 to 18 taken, but seen throughout month.
Record: 1948—July 2 (1,481010), 8 (1; 16 seen), 9 (1,481131; 36 seen), 10 (1 taken; many seen), 11 (1 taken; hundreds seen), 18 (1 taken; 8, plus many more, seen).

Homoeocera sp.

Field Characters: The bright orange body bands were distinct even in flight.
Number: Total, 25. Taken, 2.
Date: April 26 and July 5.
Record: 1948—April 26 (1 taken); July 5 (1,481066; 23 seen).

Horama panthalon (Fabr.).

Species Range: Haiti and Venezuela.
Number: Total and taken, 1.
Record: 1948—July 28 (1,481429).

Macrocneme caerulescens Dogn.

Species Range: Venezuela.
Number: Total and taken, 1.
Record: 1948—July 21 (1,481290).

Macrocneme vittata (Walker).

Species Range: Venezuela to north Brazil.
Number: Total and taken, 1.
Record: 1948—July 20 (1).

Macrocneme yepeyi Forster.

Species Range: Venezuela.
Number: Total and taken, 3.
Record: 1948—July 20 (3).

Macrocneme sp. nov.

Field Characters: Both specimens were taken on ginger blossoms in the pass. Twenty-two others, very probably of this species, were flying around in rather a dense gathering, slowly headed south.
Number: Total, 24. Taken, 2.
Record: 1948—July 20 (2,481265, 481266; 22 seen).

Mesothen sp. nov.

Field Characters: Mimicking small, black-winged dipteron.
Number: Total and taken, 1.
Record: 1948—July 15 (1,481183).

Napata alterata (Walker).

Species Range: Venezuela, Brazil, Ecuador and Peru.
Number: Total and taken, 2.
Date: June 24 and July 8.
Record: 1948—July 24 (1,481522); July 8 (1,481119M).

Napata leucotelus Butler.

Species Range: Mexico to Surinam—not reported from Colombia.
Field Characters: The white body band showed even in flight.
Number: Total, 27. Taken, 7.
Date: May 21 to July 21.
Record: 1948—May 21 (1,48540), 29 (2,48662); July 2 (1,481012; 4 seen), 21 (3,481301, 481302, 481303; 16 seen).

Poliopastea viridis (Druce).

Species Range: Ecuador.
Field Characters: A black fly mimic. The one flock was dense, flying low and slow.
Number: Total, 54. Taken, 2.
Date: July 12 and August 13.
Record: 1946—August 13 (1 taken). 1948—July 12 (1,481152; 52 seen).

Pseudosphex ichneumoneus H.-S., ab. **crabronis.**

Species Range: Central America to Argentina.
Field Characters: This is the most perfect wasp mimic taken on migration. It was caught in one sweep of the net together with a brown wasp (481037) from which it was indistinguishable on the wing. The two were pinned and catalogued together as Hymenoptera, and only later was it recognized as a euchromid. The two were flying with other small insects.
Record: 1948—July 3 (1 taken, 481038).

Syntomeida melanthus (Cr.).

Species Range: Mexico to Uruguay and Peru.
Field Characters: The banded wings set this species apart, especially when it rested on leaves.
Number: Total, 328. Taken, 18.
Date: April 27 to July 22.
Record: 1948—April 27 (1); May 29 (1; 4 seen); June 6 (1, 48717), 24 (1,48900; 11 seen), 27 (1,48968; 8 seen), 28 (5,48968A; 262 seen); July 2 (1,481011; 25 seen), 16 (2,481225), 17 (1,481238), 20 (2,481291), 21 (1,481292), 22 (1,481300).

Syntrichura reba Druce.

Species Range: Panama, Colombia, Venezuela, Guiana and Brazil.
Field Characters: Closely resembles a small wasp. On June 17, 30 or more were gathered in a group on a shrub, before they flew off south.
Number: Total, 32. Taken, 2.
Date: June 6 and June 17.
Record: 1948—June 6 (1,48714), 17 (1,48827; 30 seen).

Trichura esmeralda completa Draudt.

Species Range: Honduras, Guatemala, Colombia, Venezuela and Brazil.
Subspecies Range: Colombia.
Number: Total and taken, 1.
Record: 1948—June 6 (1,48743).

GEOMETRIDAE.

Anemplocia l. imparata Walker.

Species Range: Colombia, Venezuela, Peru and Bolivia.
Subspecies Range: Colombia and Venezuela.
Number: Total, 2. Taken, 2.
Date: May 1 and 29.
Record: 1948—May 1 (1,48477), 29 (1,481537).

Atyriodes jalapae Schaus.

Species Range: Mexico.
Field Characters: It was easy to record the presence and relative numbers of this brilliantly patterned geometrid. They came singly, or in small or very large flurries. About 2,000 were counted and it is certain many times that number were missed.
Number: Total, 2,004. Taken, 27.
Date: April 17 to September 8.
Record: 1946—September 7 (1,461157; 1,200 counted), 8 (1,461182; 250 plus counted, 22 singly). 1948—April 17 (1,48373; 13 seen), 27 (1,48419), 29 (1,481466); May 21 (2), 23 (1), 25 (3); June 15 (1), 17 (1), 18 (2; 400 plus seen, dense flocks, pure culture), 19 (1; 6 seen), 22 (1; 3 seen), 23 (1; 18 tried to pass but were beaten back by cold wind); July 6 (1), 8 (1), 15 (1), 16 (1; 12 seen), 17 (1,481502; 30th kilometer), 19 (1,381503; 15th kilometer), 20 (1; 75 seen), 23 (2,481504, 481505).

Bronchelia puellaria Guenée.

Species Range: Brazil, Paraguay and Argentina.
Field Characters: Close to *Thyrinteina arnobia*, but even a glance showed the dusky wing-tip.
Number: Total, several hundred. Taken, 1.
Date: March 15.
Record: 1948—March 15 (1,481325; several hundred migrating).

Erateina hermaea Druce.

Species Range: Venezuela, Colombia, Ecuador, Peru and Bolivia.
Field Characters: Small gray and white moths superficially like the dioptid *Polypoetes*. All taken and seen were ragged and worn.
Number: Total, about 40. Taken, 5.
Date: May 29 to June 6.
Record: 1946—May 29 (1,46666); June 6 (1,461521). 1948—June 6 (3 taken, several dozen drifting past).

Eudolophasia invaria Walker.

Species Range: Central America to Venezuela.
Field Characters: The general orange color is visible on flight and at a considerable distance. On several days the steady stream precluded accurate counting.
Number: Total, 167. Taken, 18.
Date: May 23 to September 8.

Record: 1946—July 18 (1,46785; 60 seen); September 5 (6,461133), 8 (1,461183; steady stream of migrants). 1948—May 23 (1,48579); June 16 (1; 4 seen), 17 (2,48823; 46 seen), 18 (2); July 2 (2; 14 seen), 3 (1), 4 (1; 25 seen).

Eudule cupraria Walker.

Species Range: Colorado and Arizona south to Venezuela.
Number: Total and taken, 3.
Date: July 16 to 20.
Record: 1948—July 16 (1), 17 (1), 20 (1,481558).

Eudule lobula Hübner.

Species Range: Colombia, Venezuela, Ecuador, Brazil and Argentina.
Number: Total and taken, 3.
Date: May 21 to June 15.
Record: 1948—May 21 (2,48565); June 15 (1).

Eupithecia purpureoviridis Warren.

Species Range: The type was from Ecuador.
Record: 1948—July 15 (1,481189). This is the second known specimen.

Heterusia atalantata Guenée.

Species Range: Central America, Colombia and Brazil.
Field Characters: Rarely taken or seen, except on July 18 when hundreds flew in a scattered swarm up to and through the pass. The only similar-appearing moth was the pericopid *Crocomela intensa*, one of which was taken on this date.
Number: Total, 519. Taken, 13.
Date: May 21 to July 18.
Record: 1946—May 21 (2); July 18 (6,46787; 500 plus seen). 1948—June 17 (1,48824); July 3 (1,481041; 6 seen), 8 (1), 15 (2).

Heterusia hippomenata Snellen.

Species Range: Colombia and Venezuela.
Record: 1948—May 26 (1,481523).

Melanchroia chephise (Stoll).

Species Range: Florida and the West Indies to Central America and Paraguay.
Field Characters: No other small, dusky moths were flying on the days when counts were made, so identification is reasonably certain.
Number: Total, 84. Taken, 11.
Date: May 26 to July 22.
Record: 1946—June 8 (1,46553). 1948—May 26 (1,48628); June 20 (1); July 4 (2,481054; 54 seen), 5 (2), 6 (1; 16 seen), 9 (3 seen), 10 (1), 21 (1), 22 (1).

Melanoptilon sp. nov.

Field Characters: Many thousands passed within our view, of which, on various occasions, we counted 4,481. Of my notes, I present the following, made on September 5, 1946.

"These small orange and black geometrids were the dominant species today as on many other days. They were very abundant at 2 p.m., dwindling to a small stream at 4 p.m. 2083 in count but missed hundreds. Toward the end there was only one every ten seconds. They were out of sight of each other but all took the identical path, coming up the steep gorge, slowly and wearily, a few stopping for a while on weeds. Rarely they alighted on a small flower, sometimes on the leaves but never for more than two minutes. Then on and up.

"The lee of the wind lay between two wild bananas, and nine out of ten of the moths took the same path between them, although the pass extended for several yards on each side. Insects could be seen siphoning up from an extended area on the gorge slopes, all narrowing inward as they came and bottlenecking between the two plants.

"Just above the Heliconias the wind caught the moths and whirled them about, up and back in a wide skyward curve, or forced them down close to the herbage. About one in four returned to the weeds for a rest. I never saw the same individual make more than two efforts before resting. Then a lull would come and allow a flock to attain the summit and start down toward quiet and warmth. Often the upper stretches were opaque with fog but the insects dived into it without hesitation.

"The majority seemed weary today but all I caught were freshly emerged and one laid eggs immediately."

Number: Total, 4,546 counted. Taken, 62.
Date: April 29 to September 8.
Record: 1946—July 29 (1 taken; hundreds seen), 30 (1 taken; 96 seen); August 7 (600 plus seen), 13 (1,46935; 776 seen); September 1 (1 taken; 244 seen), 5 (8,461133; stopped counting after 2,083), 7 (1,461158; 655 seen), 8 (1 taken; many passing), 9 (1,461178; 22 seen). 1948—April 29 (1); May 21 (11 taken), 22 (1), 23 (3), 24 (2,48581; 8 seen), 25 (2), 26 (4), 29 (4); June 6 (12 taken, 48719), 7 (1,481520), 9 (1); July 2 (2,481023), 5 (1), 8 (1), 16 (1).

Nelo sp. nov.

Number: Total and taken, 2.
Record: 1945—August 1 (1,45485). 1948—July 21 (1,481507).

Oospila sp. nov.

Record: 1948—May 9 (1,48520), 24 (1); July 16 (1), 21 (1,481308).

Phrudocentra opaca Butler.

Species Range: Brazil.
Number: Total and taken, 1.
Record: 1948—July 22 (1,481361).

Pseudomennis bipennis Walker.

Species Range: Central America, Venezuela to Peru and the Amazons.

Field Characters: These little orange moths, with conspicuous translucent, black-veined wing tips, are easy to recognize. Though many must have been missed, the more than 800 counted reveals their abundance.

Number: Total, 844. Taken, 28.

Date: April 30 to July 20.

Record: 1945—May 20 (1 taken); June 29 (1). 1946—July 17 (1,46787; 500 plus seen). 1948—April 30 (1); June 17 (2,48823; 46 seen), 18 (1,48834; 14 singly), 19 (1), 22 (2; 16 seen), 24 (1; 10 seen), 27 (1; 35 seen), 30 (1; 31 seen); July 2 (1), 3 (1; 4 seen), 4 (1; 56 seen), 5 (1; 66 seen), 8 (1), 13 (2; 35 seen), 14 (3 seen), 15 (4), 16 (2), 20 (2).

Ptychamalia nigricostata Warren.

Species Range: Bolivia.

Number: Total and taken, 1.

Record: 1948—May 20 (1,48527F).

Racheospila sp. nov. Perhaps a new genus.

Record: 1948—May 20 (1,48527E).

Scordylia coerulescens Dogn.

Species Range: Colombia.

Number: Total, 8. Taken, 5.

Date: April 30 to July 21.

Record: 1948—April 30 (1,48470; 3 seen); June 6 (1); July 5 (1), 21 (2).

Scordylia hippominata Snellen.

Species Range: Colombia.

Number: Total and taken, 1.

Record: 1948—May 29 (1).

Thyrinteina arnobia Cramer.

Species Range: Mexico to south Brazil.

Field Characters: Three large, faintly lined, white moths were seen and taken only once.

Number: Total, 10. Taken, 2.

Date: July 2.

Record: 1948—July 2 (2 taken, 481021; 8 on leaves, later flying south).

GLYPHIPTERYGIDAE.

Tortyra cuprinella Busck.

Species Range: Described from Panama.

Field Characters: Unrecognizable until taken, except when resting on leaves. Our records are from aerial and herbage-top net sweeping on days of dense, aerial, insect nekton. On June 22 more than a half-hundred were seen clinging to leaves in high cool wind; on July 15, twenty were taken with dozens of other small moths, and on the 21st, 17 were taken in the same way.

Number: Total, 94. Taken, 43.

Date: March 28 to July 21.

Record: 1946—March 28 (1); May 1 (1). 1948—June 22 (20,48884; 50 plus seen on leaves or taking off; 2 taken at 15th kilometer); July 15 (1,481186; 20 taken sweeping the air for three minutes. Hundreds of others must have passed), 16 (1,481229), 21 (18,481307; others seen on leaves in wind).

LITHOSIIDAE.

Argylla sp.

Number: Total and taken, 1.

Record: 1948—May 29 (1,48665).

Chrysochlorosia splendida (Druce).

Species Range: Ecuador and Bolivia.

Field Characters: This brilliant bronze-green moth is very conspicuous despite its small size.

Number: Total, 96. Taken, 25.

Date: April 30 to September 8.

Record: 1946—May 1 (3 taken); September 8 (1,461167; 38 seen). 1948—April 30 (11,48469; 21 seen); May 21 (1), 25 (1), 29 (2); June 6 (1); July 13 (1,481162; 12 seen), 16 (2,481227), 21 (2,481298, 481303).

Cisthene near **lycomorphodes** Draudt.

Number: Total and taken, 1.

Record: 1946—August 7 (1,461159).

Cisthene sp.

Number: Total and taken, 1.

Record: 1948—April 30 (1,48462).

Cisthene sp.

Number: Total and taken, 1.

Record: 1948—July (1,481185).

Metalobosia similis Draudt.

Species Range: Colombia.

Number: Total, 17. Taken, 2.

Date: May 26 and 29.

Record: 1948—May 26 (1,48623; 15 seen), 29 (1).

Odozana sp.

Number: Total, 12. Taken, 2.

Date: April 30 and June 22.

Record: 1948—April 30 (1,48463); June 22 (1,48883; about ten fluttering through pass).

Pseudomacroptila argentea Fleming.

Species Range: Rancho Grande, Venezuela.

Field Characters: Several of these moths with wings like watered silk were seen.

Number: Total and taken, 1.

Record: 1946—June 22 (1,46644; 4 others seen). This specimen proved to be representative of a new genus and species. (*Zoologica*, 1951, Vol. 36, No. 13, pp. 183-184).

LYMANTRIIDAE.

Eloria subapicalis Walker.

Species Range: Mexico to Venezuela.
Field Characters: These good-sized, gauze-winged moths were easy to recognize. They flew low and their flight was slow.
Number: Total, 154. Taken, 12.
Date: April 27 to July 26.
Record: 1948—April 27 (2,48397; 35 seen); May 26 (2); July 2 (1,481022; 80 plus passed), 8 (2,481114), 15 (2; 27 seen), 26 (3).

Eloria venosa Walker.

Species Range: Colombia.
Number: Total, 90. Taken, 4.
Date: May 25 to June 6.
Record: 1946—May 28 (1 taken). 1948—May 25 (1,48588); June 6 (2; 86 counted, probably this species).

NOCTUIDAE.

Alabama argillacea (Hübner).

Species Range: Widely distributed; southern United States to tropical America.
Number: Total and taken, 1.
Record: 1948—May 21 (1,48566).

Anticarsia gemmatalis Hübner.

Species Range: United States to Paraguay.
Number: Total and taken, 1.
Record: 1948—June 6 (1,48745).

Biosyris tuisama Schaus.

Field Characters: One tattered specimen taken at 1 p.m. in full sun going through pass. A dozen were seen at 2:30 p.m.
Number: Total, 13. Taken, 1.
Record: 1948—July 22 (1,481332; 12 passing at 2:30 p.m.).

Cydosia nobilitella (Cramer).

Species Range: Tropical America.
Field Characters: Many of these little harlequin moths appeared now and then on leaves, or flew through the pass.
Number: Total, 111. Taken, 3.
Date: June 12 to July 13.
Record: 1948—June 12 (1), 27 (1,48967; 40 seen); July 13 (1,481156; 68 seen).

Gonodonta pyrgo (Cramer).

Species Range: Southern United States to Guiana.
Field Characters: This species is essentially nocturnal and a frequent visitor to our electric lights. The four noted were flying with diurnal moths and butterflies through the pass in full sunlight.
Number: Total, 4. Taken, 2.
Record: 1948—June 29 (2,48999; 2 others flying past).

Laphygma frugiperda (Smith & Abbot).

Species Range: New World.
Number: Total and taken, 1.
Record: 1948—July 6 (male, 481143).

Sylectra erycata (Cramer).

Species Range: Tropical America.
Number: Total and taken, 1.
Record: 1948—July 21 (1,481500).

NOTODONTIDAE.

Lusura altrix (Stoll).

Species Range: Guiana and Colombia.
Field Characters: A nocturnal-appearing species, taken in full sunlight.
Number: Total and taken, 1.
Record: 1948—April 29 (1 481473).

PERICOPIDAE.

Crocomela intensa Walker.

Species Range: Venezuela.
Field Characters: These black-bordered orange moths appeared usually singly, occasionally in large numbers.
Number: Total, 767. Taken, 38.
Date: April 4 to September 9.
Record: 1946—September 9 (1,461181; 80 plus seen). 1948—April 4 (1,48355), 23 (1), 29 (1,48146); May 3 (1), 25 (2), 26 (2); June 17 (1), 28 (2); July 2 (2), 3 (2), 4 (1), 9 (1), 10 (1; 14 seen), 11 (1), 13 (1), 14 (1; 3 seen), 15 (2), 16 (2), 17 (1,48824; 232 seen), 20 (1), 21 (2), 22 (7; 400 plus seen), 26 (1).

Hyalurga leucophlebia Hering.

Species Range: Venezuela.
Number: Total and taken, 1.
Record: 1948—April 16 (female taken).

Pericopis angulosa Walker.

Species Range: Colombia and Venezuela.
Field Characters: Close mimic of large ithomiid butterfly. Probably many passed without being recognized.
Number: Total and taken, 2.
Date: May 28 and June 9.
Record: 1946—May 28 (1 taken). 1948—June 9 (1,48792).

Pericopis bivittata Walker.

Species Range: Panama to Venezuela.
Field Characters: A good butterfly mimic.
Number: Total and taken, 1.
Record: 1948—August 2 (1,481456).

Pericopis hypoxantha (Hübner).

Species Range: Venezuela, Colombia, Peru, Bolivia and Brazil.
Number: Total and taken, 1.
Record: 1948—September 3 (1,481127).

Pericopis tricolora jansonis Butler.

Species Range: Panama and tropical South America.

Subspecies Range: Panama, Colombia, and Venezuela.
Number: Total and taken, 1.
Record: 1948—August 2 (1,481499).

Sagaropsis centralis Hering.

Species Range: Venezuela.
Number: Total and taken, 1.
Record: 1948—May 21 (1,48552).

PYRALIDAE.

Acrobasis slossonella Hulst.

Species Range: United States southward.
Number: Total, 4. Taken, 4.
Record: 1948—July 22 (4,481331 A, B, C, D).

Chrysauge kadenii Lederer.

Species Range: Brazil.
Field Characters: These unmistakable yellow and black moths caught the eye easily.
Number: Total, 74. Taken, 6.
Date: June 6 to July 16.
Record: 1945—June 6 (1). 1946—June 15 (1). 1948—June 15 (1,48806; 68 seen); July 3 (2,481027), 16 (1).

Diaphania arguta (Lederer).

Species Range: Brazil.
Number: Total and taken, 2.
Date: May 20 and June 23.
Record: 1948—May 20 (1,48527C); June 23 (1,48892).

Diaphania quadristigmalis (Guenée).

Species Range: United States, West Indies and South America.
Number: Total and taken, 1.
Record: 1948—June 6 (1,48746).

Eudioptis sibillalis Walker.

Species Range: West Indies and South America.
Number: Total and taken, 1.
Record: 1948—June 6 (1,48744).

Eudioptis confinis Druce.

Number: Total and taken, 1.
Record: 1948—July 25 (1,481386A).

Lamprosema coeruleonigra Schaus.

Record: (461221). A single specimen was present, taken in migration but without exact date. Mr. Fleming records this species as being abundant in 1946, along the road just north of Portachuelo Pass.

Mapeta xanthomelas Walker.

Species Range: Mexico to Venezuela and Trinidad.
Field Characters: One of the most striking of the pyralids, both at rest and in flight.
Number: Total, 355. Taken, 14.
Date: March 28 to July 21.
Record: 1945—June 11 (1); July 12 (1). 1948—March 28 (1,48345); July 8 (3 taken; 27 seen), 15 (2 taken), 16 (2), 20 (3 taken; 80 seen), 21 (1; 234 seen).

Nachaba tryphoenalis (Felder).

Species Range: Brazil.
Number: Total and taken, 1.
Record: 1948—April 30 (1,48468).

Nymphala hermesalis Walker.

Number: Total and taken, 1.
Record: 1948—May 20 (1,48527N).

Sylepta near **excelsalis** Schaus.

Number: Total and taken, 1.
Record: 1948—May 20 (1,48527G).

Stenia sp.

Number: Total and taken, 2.
Record: 1946—August 8 (1,461185). 1948—July 21 (1,481305).

Syngamia florella (Cramer).

Species Range: Tropical America.
Field Characters: Thousands of these little gold-spots appeared day after day, only recorded a few times, but present week after week.
Number: Total, thousands. Taken, 2.
Date: May 20 to June 26.
Record: 1948—May 20 (1); June 12 (1,48788), 24 (thousands migrating), 25 (thousands for days), 26 (more than ever).

URANIIDAE.

Urania leilus (Linn.).

Species Range: Neotropics in general.
Field Characters: This famous migrant was seen only thirteen times in three years at the pass.
Number: Total, 13. Taken, none.
Date: July 14 to 26.
Record: 1945—July 14 (6 south through pass in high wind). 1948—July 16 (1 seen), 21 (1 seen), 26 (5 through pass).

MICROLEPIDOPTERA.

GELECHIIDAE.

Calliprora, near **trigramma** Meyrick.

Number: Total and taken, 1.
Record: 1948—July 15 (1,481191).

Charistica sp.

Number: Total and taken, 1.
Record: 1948—May 20 (1,48527D).

PSYCHIDAE.

Psyche surinamensis Möschler.

Number: Total, 23. Taken, 1.
Record: 1948—July 6 (1,481077; 22 seen).

TINEIDAE.

Tineid, genus?

Number: Total and taken, 1.
Record: 1948—July 25 (1,481376).

TORTRICIDAE.

Amorbia sp.

Number: Total and taken, 1.
Record: 1948—March 13 (1,48313).

Tortrix sp.

Number: Total and taken, 1.
Record: 1948—July 25 (1,481378).

ZYGAENIDAE.

Genus and Species new.

Number: Total and taken, 2.
Record: 1948—July 3 (2,481036, 481038).

EXPLANATION OF THE PLATE.

One hundred and twenty-six species of day-flying moths were taken as migrants at Portachuelo Pass, Rancho Grande, north-central Venezuela. The following forty-five have been chosen for illustration as representative species

ARCTIIDAE.

Fig. 1. *Utetheisa o. ornatrix.*
Fig. 2. *Calidota gigas.*

DIOPTIDAE.

Fig. 3. *Phanoptis fatidica.*
Fig. 4. *Zunacetha annulata.*
Fig. 5. *Josia aurifusa.*
Fig. 6. *Josia ligata.*
Fig. 7. *Josia flavissima.*
Fig. 8. *Polypoetes*, species III.

GEOMETRIDAE.

Fig. 9. *Nelo* sp. nov., near *satellitia.*
Fig. 10. near *Erateina hermaea.*
Fig. 11. *Thyrinteina arnobia.*
Fig. 12. *Atyriodes jalapae.*
Fig. 13. *Eudolophasia invaria.*
Fig. 14. *Heterusia atalantata.*
Fig. 15. *Pseudomennis bipennis.*
Fig. 16. *Melanchroia chephise.*

NOTODONTIDAE.

Fig. 17. *Lusura altrix.*

NOCTUIDAE.

Fig. 18. *Cydosia nobilitella.*

PERICOPIDAE.

Fig. 19. *Crocomela intensa.*
Fig. 20. *Pericopis bivittata.*
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MIGRATION OF DAY-FLYING MOTHS THROUGH PORTACHUELO PASS, RANCHO GRANDE, NORTH-CENTRAL VENEZUELA.

20.

Migration of Insects (Other than Lepidoptera) Through Portachuelo Pass, Rancho Grande, North-central Venezuela.[1]

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[This is one of a series of papers resulting from the 45th, 46th and 47th Expeditions of the Department of Tropical Research of the New York Zoological Society, made during 1945, 1946 and 1948, under the direction of Dr. William Beebe, with headquarters at Rancho Grande in the National Park of Aragua, Venezuela. The expeditions were made possible through the generous cooperation of the National Government of Venezuela and of the Creole Petroleum Corporation.

[The characteristics of the research area are, in brief, as follows: Rancho Grande is located in north-central Venezuela (10° 21′ N. Lat., 67° 41′ W. Long.), 80 kilometers west of Caracas, at an elevation of 1,100 meters in the undisturbed montane rain forest which covers this part of the Caribbean range of the Andes. The migration flyway of Portachuelo Pass, which is also the water-shed between the Caribbean and Lake Valencia, is 200 meters from Rancho Grande. Adjacent ecological zones include seasonal forest, savanna, thorn woodland, cactus scrub, the fresh-water lake of Valencia and various marine littoral zones. The Rancho Grande area is generally subtropical, being uniformly cool and damp throughout the year because of the prevalence of the mountain cloudcap. The dry season extends from January into April. The average humidity during the expeditions, including parts of both wet and dry seasons, was 92.4%; the average temperature during the same period was 18° C.; the average annual rainfall over a five-year period was 174 cm. The flora is marked by an abundance of mosses, ferns and epiphytes of many kinds, as well as a few gigantic trees. For further details see Beebe & Crane, *Zoologica*, Vol. 32, No. 5, 1947. Unless otherwise stated, the specimens discussed in the present paper were taken in the montane cloud forest zone, within a radius of one kilometer of Rancho Grande.

[For an account of Portachuelo Pass, together with a general introduction to the groups of migrating insects and migrating factors, see "Insect Migration at Rancho Grande," by William Beebe, *Zoologica*, 1949, Vol. 34, No. 12, pp. 107-110. Papers dealing with specific groups are as follows: Papilionidae (Vol. 34, No. 14, pp. 119-126); Danaidae, Ithomiidae, Acraeidae and Heliconidae (Vol. 35, No. 3, pp. 57-68); Pieridae (Vol. 35, No. 16, pp. 189-196); Nymphalidae, Brassolidae, Morphidae, Libytheidae, Satyridae, Riodinidae, Lycaenidae and Hesperiidae (Vol. 36, No. 1, pp. 1-16); Day-flying Moths (Vol. 36, No. 19, pp. 243-254).

CONTENTS.

INTRODUCTION

The present paper is concerned with the emigration through Portachuelo Pass of members of the following Orders of insects: Orthoptera, Dermaptera, Plecoptera, Corrodentia, Embioptera, Isoptera, Odonata, Heteroptera, Homoptera, Neuroptera, Coleoptera, Diptera and Hymenoptera. Preceding papers have dwelt with the families of Rhopalocera and day-flying Heterocera.

Relatively less attention in collecting and observation was paid to the various groups in the present paper, so they are discussed in much less detail than those in earlier publications, and comparatively few of the species have been identified. This mass emigration from north to south through a narrow pass appears to be a constant annual phenomenon, and as such may be studied by future entomologists. So I have retained all catalogue numbers and collection dates and data. In many cases I have added the purely popular descriptive names which I used in my field notes. The value of these lies only in the suggested, diagnostic characters visible in field and sight recognition.

We have no explanation for the intensive and continued emigration of these many orders, many of whose members have not before been classed as migrants. Of one thing we are certain: that in the course of three years of intermittent observation we have no record of any apparent return, of any passing of individuals in the opposite direction—from south to north.

ORTHOPTERA.

Six families of this order were represented among Portachuelo Pass migrants.

[1] Contribution No. 910, Department of Tropical Research, New York Zoological Society.

BLATTIDAE.

Only once did cockroaches appear in daytime at the pass and even this was hardly to be expected of these essentially nocturnal insects. July 25, 1948, was a sunny morning, with migration, for some unknown reason, at a low ebb. At ten o'clock I was about to give up observation when a flurry of large brown insects appeared, fluttering slowly up the gorge into full sunlight and on down the south slope.

I caught one and found it a three-inch *Blaberus giganteus* (Linn.) (481571), characterized by a general pale brownness, with a large dark spot on the thorax. Thirty would be a conservative estimate for the number in the flock. There were no stragglers, and I saw no cockroach of any kind in any other daylight migration. This species ranges from Mexico to northern South America.

PHASMIDAE.

The occurrence of stick insects as migrants parallels that of the giant blattid. June 5, 1948, was cool and rainy and very few insects attempted to scale the pass. In early afternoon there was only a scattering of small butterflies and day-flying moths and a half dozen pompilids. At two P.M. there appeared four fluttering insects, two of which I caught and found to be dull brown phasmids, both of the same species. (481572, 481572A).

MANTIDAE.

There are only two records of mantids as migrants through Portachuelo Pass. The first individual, taken on April 10, 1946, was a small green-winged species (46337); the second, on June 17, 1948, was black-winged with conspicuously dotted legs (481573). The first was solitary, but six mantids, probably of the same species, passed at the time that No. 481573 was captured.

LOCUSTIDAE.

Although locusts are symbolic of devastating hordes of migrants in many parts of the world, yet these short-horned grasshoppers were almost absent from Portachuelo Pass.

On August 31, 1946, a flock of at least three hundred small grasshoppers flew south through the Pass (461100), their only appearance as migrants. Singly, they were not uncommon around Rancho Grande, usually clinging to an upright blade of grass in a most curious position, the hind legs held akimbo, on a plane horizontal with the body. The abdomen ended in a rounded lump, almost indistinguishable superficially from the head at the opposite end of the insect.

The only other representative of the family Locustidae was the great, scarlet-winged *Tropidacris dux*, whose wings spread from eight to nine inches. In 1946, although I made no definite date records, I observed this species occasionally migrating singly or in twos and threes. In 1948 single ones were now and then seen. On June 4, 16 appeared, some of them resting for a time on the trunks of cecropia trees. On the sixth 23 came through, and two more on June 7. The last one seen was on June 26 (481399).

TETTIGONIIDAE.

A large green katydid, with broad, three-inch wings, on April 17, 1948, flew through the pass in the company of at least eight others. I took one individual, (481574).

A brilliantly colored grasshopper of considerable size, it proved to be not only a voracious carnivore, but an occasional migrant. This was *Moncheca pretiosa*, conspicuously colored violet, black and gold. The following notes were made at the pass; 1946—June 10 (1 taken; 13 others seen). 1948—July 15 (1 taken, 481575; six others seen).

A most striking tropical grasshopper migrant had its wings reticulated with green and buff, and elaborate and complex series of curved spines on head, thorax and legs. A specimen was taken May 26, 1948 (48642). Ten days later, on June 5, nine of these insects came fluttering through the pass, just out of reach, but clearly distinct in all general details.

TRIDACTYLIDAE.

These little harlequin grasshoppers, *Rhipipteryx*, are common over most of northern South America. Their usual method of progress is by a sudden, terrific leap from their specialized hind legs, ending in a long, smooth, scaling glide. I have never been certain of seeing sustained flight. Yet it is no mean member of the migrating insects in Portachuelo Pass. It was observed in small numbers on many days, mingling and passing with the flights of other small insects.

The following gives definite data for three days on the three years of our observation: 1945—March 30 (1 taken, 4541; 20 to 30 others seen). 1946—May 4 (2 taken, 46413; 848 counted in fifteen minutes. The insects flew low, looking like small chrysomelids, passing all day). 1948—June 30 (1 taken, 481004; more than 200 counted).

DERMAPTERA.

Earwigs were unusual migrants, with a curious chronological distribution, as far as our observations went. In the year 1946 four species were taken, singly, on separate dates, in full sunlight. In 1948 only a single species was observed, but on five separate occasions. This earwig was small, dark-brown, with the covered portions of the flight wings white. All appeared singly except on May 20, when several dozen of the same species were seen on leaves in the pass or flying southward. No identifications have been attempted.

The data are as follows: 1946—March 15 (1 taken, 461233), 20 (1 taken, 461234), 25 (1 taken, 461235); May 1 (1 taken, 461236). 1948—All one species; April 26 (1 taken, 48389); May 20 (1 taken, 48539; several dozen seen); June 9 (1 taken, 48753); July 5 (1 taken, 481100A), 25 (1 taken, 481380).

PLECOPTERA.

Stone flies were observed a number of times passing through Portachuelo Pass. On four occasions they were taken singly, but on April 28, 1948, twenty-seven were counted in addition to the individual netted. These were weak flyers, resembling termites in motion, or in general appearance like small wasps with banded wings. In several individuals a mass of small black eggs depended from the abdomen. Record: 1946—May 4 (1 taken, 461237). 1948—April 28 (1 taken, 48429; 27 others seen); May 21 (1, taken, 48556), 25 (1 taken, 48590); July 8 (1 taken, 481576).

CORRODENTIA.

A single specimen of psocid was taken with other insects flying south through the pass. This was on April 28, 1948, (48426).

EMBIOPTERA.

This small tropical order was represented among the migrants by a single individual. When taken in the net it was supposed to be a termite, the resemblance being in general flight, size and type of wings. No. 48672 was taken on May 29, 1948.

ISOPTERA.

After heavy rains, at the right season, termites swarmed in the vicinity of Rancho Grande. These swarms would rise into the air and become diffused, attacks by birds being apparent in all directions from the nest.

Twice, at least, swarms of these insects behaved like true migrants. On July 5, 1948, great numbers appeared far down the north gorge and worked steadily upward to the pass and on through, down the southern slope. They had hard going, for there was a fairly strong breeze against them, which drove many back again and again. Several were taken (481094).

Eleven days later, the same phenomenon was repeated, this time the flight occurring in still weather, but as directly from north to south as the first flight. This was a smaller species (481577).

ODONATA.

Dragonflies were not uncommon at the pass in the role of predators on the passing migrants, sharing this with robberflies, swallows, swifts and bats. On several occasions, however, when general migration was at rather a low ebb, I saw these insects passing in numbers. Of these I took nine individuals of five species, two of which were damselflies.

NOTE: In the records that follow, the word "taken" is often omitted from the figures in parentheses. In such cases, the first figure refers to the number of specimens taken and the figures following the comma are the catalog number.

AESCHNIDAE.

Large Transparent-winged Red-bodied Dragonfly; 1948—July 11 (1 taken, 481145; 24 seen).

Large Amber-winged Dragonfly; 1948—June 9 (1 taken, 48751; 17 passed, one of which seized a robberfly in full flight); June 24 (1 taken, 48899); July 16 (1 taken, 481578).

LIBELLULIDAE.

Four-banded Dragonfly; 1948—June 6 (1 taken, 48726); July 21 (1 taken, 481276; 18 seen).

AGRIONIDAE.

Clear-winged Damsel; 1948—June 6 (2 taken, 48724, 48725).

Amber-tipped Damsel; 1948—June 6 (2 taken, 48725A, 48726; 28 seen).

HETEROPTERA.

In the case of individuals of the less abundant orders of insects I have made no attempt at specific identification. All are furnished with distinguishing labels and catalogue numbers, and can be identified at any time. Five families of this order are represented, comprising eleven species.

PENTATOMIDAE.

Shield or Stink bugs were rarely seen on migration, although I must have missed many. Four species were taken, all but one singly. All were of good size, from 15 to 20 mm.

Glossy Black; 1948—May 29 (1, 48674).

Red-spotted Green; 1948—May 31 (1, 48682; 4 others seen).

Glossy Green; 1946—June 29 (1, 46701).

Green-winged Brown; 1948—July 24 (1, 481368).

COREIDAE.

Three species are represented by two to six individuals taken, and many others seen.

Amber-spotted; 1948—May 24 (1, 48615); June 18 (1, 48840A), 22 (1, 48840; many seen flying past), 24 (1, 48908; 12 seen); July 13 (2, 481157).

Red-eyed Black; 1948—June 6 (2, 48711, 48712).

Leaf-legged; 1948—March 27 (1, 481-580); June 6 (1, 48720; 16 flying with small butterflies).

PYRRHOCORIDAE.

Ceratocapsus balloui Knight.

Cotton Stainers represent this family. They were not uncommon in the Valencia district, and we noted them on migration through Portachuelo Pass on four different days. 1948—June 7 (1, 48761), 24 (1, 48909); July 5 (1, 481095), 16 (1, 481218; 38 seen passing).

REDUVIIDAE.

Two species of this family were noted on two occasions. 1948—April 18 (1, 481581);

June 7 (1, 48768; 15 other individuals passing in loose flock).

MIRIDAE.

Three individuals were taken of one species.

Orange-thorax Black; 1948—July 8 (1, 481123; 22 others flew past or rested on leaves before taking off), 13 (2, 481157B and C).

HOMOPTERA.

Six families belonging to this order were taken, comprising about twenty-five species.

CICADIDAE.

On six separate occasions cicadas of large size were seen in the pass, or flying through, but none were taken.

On July 5, 1948, I took a small (20 mm.) green cicada (481096), and saw 18 others within a few minutes. This was probably *Taphura* sp.

MEMBRACIDAE.

Five species were among the migrants, three taken singly, two accompanied by small numbers.

Rugose Brown; 1948—April 29 (1, 48431; 11 seen).

Three-pronged; 1948—May 20 (1, 48532, taken in flight; 8 others seen).

Cream-fronted Giant-keel; 1948—May 26 (1, 48633; four seen).

Black-spotted Keeled; 1948—May 24 (1, 48614).

Large, Glossy-black; 1948—May 1 (1, 481582).

FULGORIDAE.

Among the migrants were five species. Only one of these showed the scarlet flash coloring of many tropical species.

Three-spined Snouted; 1946—March 27 (1, 46295; six others were seen); May 23 (1).

Half-black-and -clear-wing; 1948—May 24 (1, 48612); July 5 (1, 481097; 16 others on leaves and passing).

Half-brown-and-clear-wing; 1948—March 15 (1).

Small Snouted; 1948—May 24 (1, 48613).

Small Clearwing; 1946—June 13 (1, 46571).

CERCOPIDAE.

Five species of froghoppers were recorded as migrants. In the case of three of these, individuals were seen to the number of several hundred.

Yellow-banded Brown; 1948—July 3 (1, 481035; 40 odd seen).

Yellow-banded Black; 1948—June 21 (1,48868; several hundred flying about, slowly southward), 24 (1,48910; 32 seen).

Scarlet-banded Black; 1948 July 8 (1, 481127; we counted more than four hundred), 15 (1,481180).

Large Scarlet-and-black; 1948—July 13 (1,481158), 14 (1), 26 (1,481390; eight seen).

Small Amber; 1948—June 21 (1,48867; many on leaves), July 4 (1,481057).

CICADELLIDAE.

Large Ivorywing; 1948—July 2 (1,481017; 16 of these conspicuous insects counted in company with the one taken).

Medium Brown; 1948—June 23 (1,48894; 4 others caught in cobwebs.

Greenwing; 1948—June 24 (1,48907).

Clear-tipped Black; 1948—July 2 (1,481-016; six on leaves and flying.

Three Minute Species; 1948—July 22 (1, 481363), 24 (1, 481381), 25 (1, 481383).

ALEYRODIDAE.

On April 24, 1948, a small cloud of these insects passed, of which I caught one (481583). All trailed waxy threads.

NEUROPTERA.

CORYDALIDAE. Dobsonflies.

Dobsonflies were seen migrating on several occasions. Their size and their slow, fluttering flight made sight identification easy. On May 14 a flurry of about fourteen of the pale yellow-winged species was driven down to the low shrubs at the pass by a strong wind. Some took shelter among the foliage, but all, in time, seemed able to make their way through the branches and down the farther slope.

Large Brown-winged (length 80 mm.); 1948—June 15 (1, 48807; 3 others seen).

Pale Yellow-winged (length 48 mm.); 1946—May 5 (1, 46421). 1948—May 14 (1, 48524A; 14 others seen).

MANTISPIDAE. Mantislike Neuroptera.

Only by examining the results of net sweepings on days of abundant nekton migrants could the presence of these delicate little insects be proved. They were detected on several days. 1948—June 29 (1, 481397); July 14 (4 taken at once, 481493).

MYRMELEONIDAE. Ant-lions.

Only 2 individuals were seen or taken at the pass. Both were in flight, in full sunlight in company with such unlike fellow migrants as pompilids and day-flying moths. 1948—May 26 (1, 48600), 30 (1, 48676).

COLEOPTERA.

Seventeen families of beetles were taken as very evident migrants through the pass. Some of these appeared singly, but in several cases they vied in sheer numbers with the other most abundant migrants, passing steadily, day after day, week after week. Comparatively few Coleoptera have been specifically identified, but catalogue numbers and dates have been provided, and for hints of diagnostic field characters we have added our tentative field names.

Carabidae.

Four species represent this family among the migrants. The *Calosoma* came occasionally to our electric lights.

Calosoma sp. 1948—June 30 (2, 481000, 481003; 12 others on leaves and flying); July 7 (1).

near *Euproctus;* 1948—March 22 (1, 481588).

near *Carabus* (1st species); 1946—April 15 (1, 46332).

near *Carabus* (2nd species); 1946—July 12 (1, 46769).

Staphylinidae.

Eight species of these beetles were recorded as migrants. All, with one notable exception, were represented by only one or two individuals. What I called the Iridescent Staphylinid, conspicuous in glowing copper and emerald, sometimes came through the pass in scores or even hundreds.

Iridescent Staphylinid; 1946—April 26 (1), 28 (1; 12 seen). 1948—May 24 (1); June 6 (2, 48708, 48710), 15 (1, 48801; 52 seen), 27 (1, 48969; 24 counted), 30 (1, 481005; 6 seen); July 2 (2, 481019, 481020), 4 (1; 6 seen), 15 (2, 481201; 481202; 15 seen), 16 (2, 481231, 481232; several hundred seen), 21 (1, 481288; 48 seen).

Amber and Green; *Paederes culumbrinus;* 1945—June 12 (1, 45310). 1946—April 27 (2, 46398). This record is based on three beetles resting on leaves at the summit of the pass, one of which took off to the south. The species appears, however, to be essentially nocturnal, as it thronged our Rancho Grande rooms at night, from April 16 to 28. Incidentally, its touch often caused a severe skin eruption.

Golden-buff; 1948—July 25 (1, 481384).

Copper-thorax; 1946—June 26 (1, 46674).

Green-punctate-thorax; 1946—June 26 (1, 46673).

Bronze-thorax; 1946—June 26 (1, 46671). 1948—July 4 (1, 481059).

Square-thorax; 1948—July 5 (1, 481059).

Rugose Brown; 1946—March 27 (1, 46298). 1948—July 21 (1, 481322; resembled bee in flight).

Lycidae.

About eighteen species of this family appeared as migrants at the pass. Only four were seen in numbers, but the majority of the other forms were so small and inconspicuous that there may have been many more than came to our attention. The calopterons resembled small moths and beetles in flight.

Calopteron sp. Buff-banded Black; 1948—April 28 (1, 48425; 18 seen); June 9 (1, 48779); July 14 (1, 481169; 8 others seen and 2 pairs mating in flight), 15 (1, 481194), 17 (1, 481236), 21 (2, 481283, 481284; 16 flying like moths), 23 (2, 481341, 481342; 12 seen).

Calopteron sp. Two-banded Orange-and-black; 1948—June 7 (1, 48767; 15 seen), 28 (1, 481412).

Lycostomus sp. Half-blue-half-orange; 1948—April 27 (1, 48418; 16 seen), 28 (2, 48424; 22 seen); July 15 (2, 481192, 481193; 42 counted on leaves and flying).

Thirteen Small, Unnamed Lycids; 1946—September 8 (461164). 1948—April 27 (48417). May 24 (48610). June 24 (48905). June 29 (48988). June 30 (481006). July 2 (481013). July 8 (481112). July 9 (481134). July 13 (481157). July 15 (481195). June 10 (481413). June 24 (481414).

Histeridae.

Hololepta sp. Recorded only once, on June 22, but the leaves were covered with many of these little beetles. Four flew south as I watched. 1948—June 22 (1, 48889).

Lampyridae; Fireflies.

Ten species of fireflies defied the sun's glare in migration, and were taken passing southward in full daylight through Portachuelo Pass.

Large Wavy-buff Black; 1948—July 2 (1, 481015).

Two-spotted Thorax; 1948—May 24 (1, 481590).

Pale-brown; *Aspidosoma* sp. 1948—April 26 (1, 481591).

Black-spotted Buff; 1948—July 9 (1, 481129).

Pale-edged; 1948—May 2 (1, 48440A), 24 (2, 48609); June 10 (1, 48759; 18 seen); July 5 (1, 481093), 17 (2, 481235; 4 seen).

Single-vaned Feather-antennae; (two species); 1946—March 22 (1, 461088). 1948—July 26 (1, 481389).

Double-vaned Feather-antennae; (two species); 1948—March 15 (1, 481592); April 16 (1, 48370); July 13 (1, 481157).

Phengodidae.

Three species of Feather-antennae Beetles were taken.

Large; 1948—April 29 (1, 48433), May 6 (1, 481585), 14 (1, 481586).

Medium; 1948—May 4 (1, 48485).

Small; 1946—March 19 (1, 46271).

Cantharidae.

A single striking species of this family appeared as a migrant, making up in number of individuals what was lacking in additional species. The elytra are half yellowish-brown and half dark blue. When annoyed the beetle rolls itself into a tight ball with the wings protruding, making an excellent imitation of a wasp in the act of stinging. 1945—May 8 (1). 1946—July 17 (1, 46788; a steady stream of more than 800); September 5 (235 seen). 1948—June 6 (2, 48705), 16 (2, 48809), July 3 (1,481042; many passing), 6 (1; 6 seen), 8 (3, 481126; 27 counted), 13 (1, 481161), 14 (1), 16 (1), 21 (1, 481321; 78 seen).

MELOIDAE.

Two small, brown oilbeetles were the only ones taken or seen on migration; 1946—March 8 (1, 461086); May 5 (1, 461085).

ELATERIDAE.

As migrants we recorded fourteen species of elaters. Eight of these were taken singly; the remainder were accompanied by a fewer or greater number of individuals, flying past at the time. In flight these beetles were sometimes confused momentarily with wasps of corresponding size, but this only at a distance. A few have been identified. I have applied to all the descriptive names I used in my field journals.

Large Striped Elater: *Semiotus imperialis* Guérin; 1948—April 20 (1), 27 (1; 5 seen), 28 (1, 9 seen), 29 (1, 48432); May 11 (1; 15 seen), 23 (1, 48580); June 30 (1; 6 seen), July 6 (1; 7 seen).

Large Five-spotted; *Semiotus insignis* Caud.; 1946—April 4 (1, 46419). 1948—July 10 (1, 48781; 8 seen), 28 (1, 48980; 12 flying out of reach).

Medium Many-striped; *Semiotus* sp.; 1946—May 11 (1, 46450; 15 seen). 1948—June 9 (1, 48752), 22 (1, 48888; 16 seen in 10 minutes); July 10 (1, 481140; 9 counted), 15 (1, 481196), 21 (2, 481281, 481282; 10 flying singly).

Half-orange-and black; *Semiotus caracasanus* Caud.; 1948—July 2 (1, 481014; 4 seen), 18 (1, 481245).

Scarlet-thorax; *Semiotus* sp.; 1948—May 27 (1, 48637; 4 seen); July 15 (1, 481197), 23 (23 seen).

Common Eyed Elater; *Pyrophorus noctilucus* Linn.; 1948—April 30 (1, 48436).

Square-thorax Brown; *Chalcolepis luczotii* Caud.; 1948—April 25 (1, 481584).

Black-dotted Red; *Coroderus* sp.; 1948—June 15 (1, 48800).

Small, White-dotted Black; 1946—July 6 (1, 46742), 12 (1, 144 seen on leaves and flying).

Small, slender Brown; 1948—July 3 (1, 481044).

Three Minute Species (ca. 3 mm.); 1948—July 22 (3 individuals of 3 species; 481364 A, B and C).

Small, Black-tipped Brown; 1948—May 21 (1, 48562).

BUPRESTIDAE.

A single large, green, buprestid was taken going south through the pass. 1948—August 10 (1, 481589). A second, minute (3 mm.) bronze-wing was flying with other small insects on September 8, 1946 (461169).

EROTYLIDAE.

Four species of erotylids were among the migrants. All were taken one at a time, and in no case more than four of one species. All were mingled with other forms flying south through the pass.

Black-speckled Brown; 1946—March 16 (1, 461089). 1948—May 15 (1, 481410); July 10 (1, 481150), 26 (1, 481396).

Dull-brown; 1948—June 16 (1, 48812); July 23 (1, 481338).

Glossy-brown; 1948—July 3 (1, 481048), 21 (1, 481287).

Black-banded Brown; 1948—July 16 (1, 481230).

TENEBRIONIDAE.

Two unidentified species represent this family among the migrants.

Bronze-winged; 1948—May 24 (1, 48618).

Purple-ridged; 1948—June 9 (1, 48778).

SCARABAEIDAE.

Daylight migrating scarabs number twenty species, ranging from 10 mm. melolonthas to giant hercules beetles. Almost all the forms appearing in diurnal migration also came to our lights, at night, on Rancho Grande roof. As we have made few identifications, I have used the tentative popular names which I used in my field journals.

Dung Beetles; Three specimens of three species were taken singly. I expected larger numbers, judging by the usually diurnal habits of these beetles when reacting to food.

Horned Scarab (two small species); 1946—May 25 (1, 46513). 1948—June 18 (1, 48839; 16 in a few minutes); July 4 (1).

Macrodactylus, Rose Beetles; Seen migrating on seven occasions, and almost always in numbers; 1946—June 7 (1, 46548; 12 others seen). 1948—May 24 (1, 48605); June 6 (4, 48699; 68 counted passing); July 4 (1), 5 (1, 481092), 15 (1, 481198; 43 seen), 18 (1).

Dynastids, Hercules Beetles; On four occasions we saw the great Hercules Beetles, *Dynastes hercules* (Linn.), flying through the pass. On July 4, three followed each other closely. One circled several times before heading south. I took only one, 1948—May 28 (1, 48674). These insects were more commonly seen at night at our electric lights.

Small (10-15 mm.) Junebugs or Melolonthinae. *Cyclocephala* sp., Punctated Brown Beetle; This was the most abundant species of beetle seen on migration. It was present on almost every day of observation, either singly or with 10 to 40 in sight at once. From May 24 to the last of July, a steady stream passed on most days. On June 20 and July 9 and 22 there were especially large eruptions, when thousands came over en masse. Thousands could have been taken. They often got into our nets by mistake when we were sweeping for other rarer insects. I list only a few of those taken. 1946—May 7 (2, 46547, 46548). 1948—May 24 (1, 48603); June 9 (1, 48755), 15 (1, 48805); July 4 (2, 481064, 481065).

Small Hairy Beetle; These were abundant as daytime migrants, but many thousands came, night after night, to our lights. 1946—April 15 (46336), 16 (1), 27 (1, 46399; dozens passed all day). 1948—June 29 (2, 48992; hundreds day after day).

Cyclocephala, two species; 1946—April 16 (1). 1948—June 14 (1, 48793; fifty plus seen).

Three very small melolonthids; 1948—June 29 (1, 48995). 1948—July 26 (1, 481351). 1948—July 25 (1, 481385).

Large (22-27 mm.) Junebugs or Melolonthinae.

Seal-brown Cetonia; *Gymnetis* sp.; 1948—August 15 (1, 481587).

Iridescent Green; *Platycoelia* sp.; 1946—April 17 (1). 1948—April 26 (1); July 20 (1, 481261).

Black-thorax Iridescent Brown; *Chlorata* sp.; 1946—May 21 (1, 461087).

Bronze-thorax Iridescent; 1948—June 15 (1, 48797; 4 seen).

Black-mottled Pelidnota; *Cyclocephala mafaffa* Burm.; 1946—April 26 (1); May 5 (1), 6 (1, 46440). 1948—June 22 (1, 48887).

Black-spotted Pelidnota; *Ancognatha humeralis* Burm.; These were common also at night, at our lights. 1946—March 25 (1); August 31 (1, 46998). 1948—June 16 (1, 48814); July 22 (1, 481326).

Black Junebug; 1946—April 27 (1, 46400; hundreds passing in dense swarm).

Iridescent Copper; *Macraspis chalcea* Burm.; 1946—April 20 (1). 1948—June 7 (1, 48750; 22 counted in one hour); July 22 (1).

Hairy Iridescent Copper; 1948—July 20 (1).

Cerambycidae.

Twenty species of longicorns were found to be migrants through Portachuelo Pass. None were abundant, but a few occurred in considerable numbers. A few, in actual size and weight, were second only to the rhinoceros beetle; two were strongly perfumed and others produced a varied assortment of squeaks. Certain ones bore, especially in flight, a striking resemblance to wasps and flies. I append some of my diagnostic field names.

I am indebted to Henry Fleming for most of the scientific names of this family.

Acrocinus longimanus Linn. Long-armed; 1946—April 1 (1, 46350); June 1 (1). 1948—Seen flying through on four occasions.

Adesmus griseus Auriv. White-frosted Ivory; 1948—June 9 (1, 48776), 24 (1, 48901); July 8 (1, 481120), 26 (1, 481395).

Brasilianus plicatus Olivier. Brown-wing; 1948—June 10 (1, 48782).

Callichroma vittata Fabr. Perfumed Emerald; 1948—June 17 (1, 48826; 6 others seen); July 4 (1, 481062); On the wing and in the net this was mistaken for a wasp, due to the nervous, jerky movements, long, quivering antennae and the greenish wing sheen. The pinned insect shows no hint of this resemblance.

Cyllene cayennensis L. & G., Wasplike; 1948—May 5 (1, 48492).

Eburodacrys callixantha Bates. Six Ivory-spot; 1948—May 24 (1, 48619).

Hippopsis assimilis Breuning. Thread-horned; 1948—June 24 (1, 48906; Mistaken for a wasp, only when in the hand were the elongate, threadlike antennae visible); July 3 (1, 481046).

Hippopsis sp. nov. Buff-striped Dwarf; 1948—May 24 (1, 48611).

Jamesia papulenta Thomson, Brown Death-feigning; 1946—April 11 (1, 46522).

Listroptera aterrima Germar, Fly-like; 1948—July 15 (1, 481199; on the wing almost impossible to tell from a small black fly).

Myzomorphus quadrimaculatus Gor. Semi-elytra; 1948—July 6 (1, 481078), 16 (1, 481221).

Parandra glabra (Degeer). Small Brown Prionid; 1948—May 25 (1, 48594); June 8 (1, 48775, a not uncommon migrant); July 8 (1, 481127), 9 (2, 481138).

Psalidognathus sallei Thomson. Giant, Green Crook-jaw; 1946—April 16 (1, 461098). 1948—July 16 (2 at pass, 3 at Rancho Grande Bridge, all flying south). Seen several times migrating in 1948.

Pteridotelus laticornis White. Gray Death-feigning; 1946—August 2 (1, 46882). 1948—May 25 (1, 48596); June 10 (1, 48758).

Steirastoma melanogenys White. Thorn-thorax; 1948—May 24 (1, 48616).

Stenodontes spinibarbis (Linn.). Large-jawed Prionid; 1948—May 25 (11); June 13 (one taken with 24 ripe eggs, 6.5 by 2.5 mm.), 16 (1, 48813; 13 others seen); July 8 (1), 9 (1, 481138).

Taeniotes scalaris Fabr. Long-horned Ladder; 1946—May 30 (1, 46522).

Titanus mundus White. 1948—June 16 (1, 48813).

Trachyderes polita Bates. White-banded; 1946—April 30 (1, 46410).

Chrysomelidae.

As might be expected, flower beetles were present in great numbers among the migrants. Upwards of fifty species were taken, some singly, others in small lots and one or two in very great numbers. This was especially true of *Diabrotica quindecimpunctata* Ger. On almost every day of migration, these little black-spotted beetles passed, throughout the hours of daylight, either one by one or in more or less numerous swarms. Their total number was beyond credible computation. The abdomens of many were swollen with eggs.

Diabrotica quindecimpunctata Ger. I list only five of the many taken, and make no attempt to give even approximate count of the vast numbers. 1946—March 16 (1, 461097). 1948—May 1 (1, 48440); June 18 (2, 48837), 24 (1, 481596); July 8 (1, 481127). In life these beetles are rather brilliant; thorax chrysophrase green, elytra yellow ochre, which quickly fade after death.

No attempt has been made at identification of the remaining species. This will be the labor of some chrysomelid specialist. I can give only catalogue numbers and dates. It

must suffice to say that the well-known genera *Lema, Lachica, Haltica, Doryphora, Batanota, Coptocycla* and *Oedionyches* were all represented.

The following unidentified species of chrysomelids are given in chronological order accompanied by their respective catalogue numbers.

1946—March 16 (461094); March 16 (461095); March 18 (46267, 46267A); March 25 (461090); March 27 (461093); March 30 (46312); April 17 (46339); April 18 (461096); April 26 (461092); April 29 (461091); May 23 (46491); July 18 (46800).

1948—March 16 (481594); April 17 (481593); April 18 (481595); April 30 (48435); May 13 (48521); May 21 (48561); May 25 (48597); May 25 (48598); May 24 (48604); May 24 (48606); May 24 (48607); May 24 (48608); May 27 (48640); May 29 (48670); May 29 (48675); May 30 (48677); May 30 (48678); May 30 (48680); June 7 (48770); June 7 (48774); June 9 (48777); June 11 (48786); June 11 (48787); June 12 (48790); June 17 (48829); June 18 (48838); June 19 (48854); June 19 (48855); June 21 (48866); June 22 (48878); June 24 (48902); June 24 (48903); June 24 (48904); June 29 (48986); June 29 (48987); June 29 (48994); June 30 (481008); July 8 (481127); July 10 (481149); July 17 (481240); July 17 (481241); July 20 (481262); July 20 (481263); July 21 (481286); July 21 (481289); July 22 (481328); July 27 (481398); July 15 (481409); July 7 (481411).

Brentidae.

Three species of these beetles were taken at Portachuelo Pass. On twelve days on which brentids were captured, only five appeared singly, so their status as migrants is undoubted. Twice, at a distance, I mistook them for wasps, but nearby there was no mistaking their identity.

Large (27 mm.) Orange-banded; 1946—March 13 (2, male and female, 461083, 461084; 12 seen); April 10 (1). 1948—June 22 (1, 48873; 13 seen); July 20 (1, 481334), 22 (1; 35 seen), 23 (1, 481338; 34 counted).

Small, Orange-dotted; 1948—July 13 (1, 481162).

Red-lined Black; 1946—March 26 (1, 46293; 7 seen). 1948—April 16 (1); May 27 (1, 48639; 4 seen); July 3 (1, 481043), 23 (1, 481339; 7 counted).

Curculionidae.

More than forty species of weevils took part in the migration. Identification on the wing was practically impossible, so few notes on specimens other than those taken could be made with any certainty. No attempt has been made at scientific identification, but I have added my diagnostic field names. These insects varied in size from 2 to 25 mm. The majority were of such small size and swift flight that it was impossible to distinguish even their family on the wing. In one sweep of the net we took as many as five species and 13 individual weevils. All the weevils listed were taken in 1948.

Lichen-covered; April 15 (48369).
Hump-backed; May 20 (48535).
Large, Yellow-powdered; May 21 (48557).
Buff-and-brown Rugose; May 21 (48558).
Two-lined Shining; May 21 (48559).
Brown Pygmy; May 21 (48560).
Sage-green Pitted; May 21 (48561).
Black-tipped Pygmy; May 21 (48562).
May 25 (48590).
Large Amber-and-black Beaded; May 25 (48595).
Large Black-beaded; May 24 (48601).
Large-footed Black; May 24 (48602).
Black Rough; May 27 (48641).
Pale-striped; June 6 (48699).
June 6 (48707).
Rugged Brown; June 10 (48758).
High-rumped; June 6 (48773).
Mosaic; June 15 (48798); June 16 (48810); June 21 (48964); June 26 (481285).
Brown-and-buff; June 16 (48811).
June 22 (48890).
Black-and-white; July 5 (481091).
Brown-and-black; July 7 (481107).
Black; July 10 (481142).
July 13 (481157).
Pearly; July 13 (481159).
White-flanked; July 13 (481160).
Yellow-and-black; July 13 (481161).
Sequin; July 15 (481200).
Rugose Checkered; July 15 (481203).
Large White-checkered; July 17 (481239).
Wood-brown; July 19 (481250).
Greenish-white; July 19 (481251).
Pebbled; July 20 (481264).
Sepia; July 21 (481285).
July 24 (481367).
July 25 (481382).
Red-spot; July 27 (481422).

DIPTERA.

Owing to the limitation of daylight hours and of sheer physical endurance throughout the weeks of studying migration at Portachuelo Pass, we naturally devoted more attention to the larger, more perceptible forms of insects. This resulted in the relative neglect of such small sized groups as Diptera.

The result of casual collecting was the recording of 34 species of flies, belonging to 17 families, all undoubted migrants. The residual richness of others which would have rewarded more intensive collecting of this Order is indicated by two notes.

On July 24, when there was a steady stream of passing nekton migrants of small size, several sweeps of a net captured a mass of insects which, at the time, I labelled as "small flies, mosquitoes and gnats." Part of these ultimately resolved into 13 species of 9 families of Diptera. On the very next day, July 25, a corresponding method of collecting netted 4 families of craneflies, of 5 species, two of which were new. On May 29, a *Bibio*, No. 48671, taken, was accompanied

by a veritable mist of others, slowly drifting through the pass. As in other orders the total number of fly migrants must have been legion.

My thanks go to Dr. C. H. Curran for identifications.

ASILIDAE.

Lastaurus anthracmus O.S.; 1948—June 7 (2, 48764).

BIBIONIDAE.

Bibio sp; 1948—May 29 (1, 48671; cloud of others passing).

Plecia confusa Loew; 1948—July 21 (1, 481318).

Plecia sp.; 1948—July 21 (1, 481317).

CULICIDAE.

Culex sp.; 1948—July 24 (2, 481354, 481355).

Mansonia sp.; 1948—July 24 (1, 481358).

DOLICHOPIDAE.

Condylostalum dimidiatus Loew; 1948—June 26 (1, 48963; hundreds passing, 26 taken in one sweep of the net).

DROSOPHILIDAE.

Drosophila sp.; 1948—July 24 (4, 481345, 481346, 481349, 481359).

LAUXANIIDAE.

Pseudocaliope sp.; 1948—July 24 (1, 481357).

MICROPEZIDAE.

Scipopus sp.; 1948—June 6 (1, 48697).

MYCETOPHILIDAE.

Mycetophila sp.; 1948—July 24 (1, 481379).

ORTALIDAE.

Acrosticta sp.; 1948—(2, 481348, 481352).

Euxista sp.; 1948—(1, 481350).

PYRGOTIDAE.

Genus ?; 1946—April 28 (1, 46428; flurry of about 20 passing).

RHAGIONIDAE.

Chrysophilus sp.; 1948—July 24 (1, 481127A).

SAPROMYZIDAE.

Minettia sp.; 1948—July 24 (1, 481343).

Pseudogyrphoneura sp.; 1948—July 24 (1, 481344).

STRATIOMYIDAE.

Aloipha sp.; 1948—July 24 (1, 481320).

Anatella sp.; 1948—June 21 (1, 48869; many flying south, 6 taken in one net).

Merosargus sp.; 1948—July 24 (1, 481347).

Spaniomyia pulchripennis Br.; 1948—May 21 (1, 481308).

SYRPHIDAE.

Baccha clavata Fab.; 1948—June 22 (1, 48877; hundreds).

Baccha dimidiata Fab.; 1948—July 20 (1, 481267; many seen).

TACHNIIDAE.

Tachniid genus?; 1948—July 24 (1, 481356).

Rhynchiodexia sp.; 1948—June 22 (1, 48876; several hundred alighting and flying).

THEREVIDAE.

Psilocephala sp.; 1946—May 14 (1, 461238).

TIPULIDAE.

Erioptera beebeana Alex.; 1948—July 25 (1, 481374A).

Erioptera celestis Alex.; 1948—July 25 (1, 481374B).

Limonia angustifasciata Alex.; 1948—May 23 (1, 481457A; see note under *Tipula lichyana*); July 21 (1, 481275; many flying past).

Neognophomyia monophora Alex.; 1948—July 25 (1, 481374C).

Paradelphomyia venezolana Alex.; 1948—July 25 (1, 481374D).

Shannonomyia araguae Alex.; 1948—July 25 (1, 481374E).

Shannonomyia providens Alex.; 1948—July 22 (1, 481365; numbers of this species (?) passing).

Tipula lichyana Alex.; 1948—May 23 (1, 48569; two species in great numbers on leaves, caught in spider webs, and passing south); June 14 (1, 481457).

HYMENOPTERA.

Together with the migrants of thirteen other orders, no fewer than fifteen families of Hymenoptera came zooming through Portachuelo Pass. Many appeared in enormous numbers; ichneumonids so small and delicate that they often became visible only in full sunlight; giant pompilids and scoliids followed one another in unending files, day after day; uncounted thousands of yellow-jackets, and bees, from euglossids of largest size, down to tiny trigonids. In numbers and in the loud humming of wings, Hymenoptera formed a very appreciable percentage of the insect horde pouring across the summit of the pass, always from north to south. Only a relatively few Hymenoptera have been identified. To give hints of prominent field characters I have added names from my journal.

TENTHREDINIDAE.

Tenthredinid genus and species? Two specimens of sawflies were taken; 1948—May 26 (1, 48632); June 20 (1, 481603).

ICHNEUMONIDAE.

Near *Ophion;* A small (12 mm.) slender form was a very abundant migrant. A note made on June 22 will serve as a sample of

our observations. "Beginning at 7:30 A.M. these very small ichneumonids appeared in large numbers, as they have throughout the whole of the month. They fly low and rather slowly, and a single sweep of the net sometimes captured from 3 to 15 of these insects. We must have taken hundreds inadvertently, and liberated them." 1948—May 20 (1, 48536); June 7 (1, 48772; 6 others in net), 22 (3, 48871), 29 (1, 48995); July 15 (2, 481175, 481176).

Near *Rhyssa;* 1948—June 5 (1, 48693; 12 others seen; ovipositor 65 mm. in length).

Various ichneumonids; 1948—April 30 (1, 48471); May 20 (1, 48533; dozens flying and resting on leaves), 20 (1, 48534; 4 others in net), 26 (1, 481417; several hundred alighting and flying), 26 (1, 48634), 25 (1, 48591), 27 (1, 48638); June 6 (1, 48695), 6 (1, 48696), 6 (1, 48704), 6 (1, 48706), 6 (1, 48718), 15 (1, 48803), 19 (1, 48857; 2 others in net, 6 on leaves), 24 (1, 48911), 30 (2, 481007; 3 in net); July 2 (2, 481313, 481314).

Pelecinidae.

These were occasionally seen among the migrants, the females being especially easy to identify on the wing and to catch. Several were often in sight at once, on their way south. Six were taken, of which one was a male. 1946—March 5 (1). 1948—June 19 (1 male, 48856; several more seen), 23 (1, 48893; 4 resting under leaves, 12 passing slowly), 24 (1, taken; 6 under leaves, 18 others flying slowly), 25 (6 seen); July 6 (1 taken, 4 seen), 8 (3 seen), 13 (1, 481157A), 14 (1, 2 seen), 15 (1, 481188).

Cynipidae.

Four individuals of these gall-making Hymenoptera were taken when flying through the pass. On July 4 they were in such numbers and exhibited such persistently southward flight as to ensure their inclusion in the category of true migrants. 1948—July 5 (4 in one sweep of the net; 28 others counted crawling about on leaves, on my hands, and occasionally taking to wing and joining the quantities of small migrants passing at the time), 16 (1, 481210).

Pompilidae.

These large insects were conspicuous migrants, and from first to last, many hundred were seen. They usually passed singly, high or low, according to the weather, with direct flight. Many, however, stopped to rest on leaves, especially in stress of fog or wind, to preen for a while and then to continue. They passed along two favorite routes, definitely through openings in the low shrubs, and day after day they could be accurately clocked. In their case, as in many other insects, there was a remarkable segregation of species. If several specimens of the orange-antennaed *Pepsis* were taken, the succeeding passing individuals were more than likely to be of the same species.

Pepsis spp. Tarantula wasps; 1948—June 5 (1, 48723; 9 on leaves and flying. Later, counted 14 singly. The orange antennae were conspicuous in the sunlight), 6 (1, 48722, three inch spread; 15 flying singly; not a single orange-antennaed), 7 (1, 48765; 9 seen); July 3 (another flight of the orange-antennaed; counted 42, many forced to alight), 4 (4 more orange-antennaed seen), 9 (1, 481132; 32 *Pepsis*, uncertain species, flying high and fast), 10 (1, 481141; 3 others seen, unknown species), 21 (1, 481279; 28 counted).

Various pompilids:

Golden-wing; 1948—March 28 (1, 481-418); May 30 (1, 48679).

White-shouldered; 1948—June 28 (1, 48979).

Half-amber-antennae; 1948—July 3 (1, 481034).

Amber-antennae, Small Greenwing; 1948—July 10 (1, 481139; 4 others seen).

Amber-antennae Small Brownwing; 1948—July 23 (1, 481034).

Opalwing; 1948—July 13 (1, 481139).

Scoliidae.

Several species of scoliids are included in the following list of migrants. For convenience in the field I provided common names as well as individual catalogue numbers. Complete taxonomic identifications will have to be postponed.

Several species were observed in considerable numbers, usually flying singly through one of two narrow, open lanes at the top of the pass. In strong wind the insects often alighted, affording good opportunities for confirming sight identification.

To emphasize absorption in the pull of migration I caught a scoliid, *Campsomeris ianthina.* I netted it at the pass in full flight, carried it two hundred feet out to the main road, swung it rapidly in the net, about fifty times, then liberated it. The insect crawled to the top of the net, preened for a few seconds, took to wing, flew twice in circles overhead, and set a straight course to the south.

Campsomeris ianthina Bradley; Giant Scoliid (75 mm. wing spread: 45 mm. length); 1948—March 28 (1, 481597); April 29 (1, 48434; 48 counted singly), 30 (1, 481419); June 5 (1, 48692; 9 seen), 6 (2, 48721), 19 (1, 48765), 21 (2, 481420, 481598); July 8 (1, 481125; 294 counted, mostly singly, or alighted in groups, during 3 hours. No other species).

Days of special abundance, June 17, 18 and 27.

Medium Scoliids (length 30 mm.); 1948—June 15 (6, 48681; 34 others counted; these have been passing for weeks); July 11 (89 counted), 29 (1, 481309). Days of unusual abundance, June 9, 10 and 28; July 4 and 11.

Small Amberwing Scoliids (length 23 mm.); 1948—June 11 (1, 481599), 22 (1, 48872; numbers passing. In sudden rain 8

in a group clutched the underside of a leaf. To this they clung tenaciously until carried almost to Rancho Grande, when they all left, took to wing, circled and flew off southward.), 24 (1, 48916; several others); July 16 (3, 481214, 481600, 481601).

Clear-winged Scoliids (length 35 mm.); 1948—June 24 (1, 48917), 22 (1, 48886).

Formicidae.

This leaf-cutting ant is included in this list only because of two mass movements through the pass from north to south. These flights of the mature sexes of *Atta* did not originate in any local nest, and on both occasions the movement was against adverse conditions of wind. Local nuptial flights on other occasions, were diffuse and no individuals were seen flying with the migrants. (Compare with Isoptera). 1948—May 23 (2, 48571, male, 48571A, female); June 7 (1, 48766, male).

Vespidae.

A dozen species of Vespidae were taken and there must have been many other species which passed unseen or uncollected. Two or three species were among the most abundant of the daily migrants, hundreds passing day after day. On days of weather stress, the foliage would sometimes be covered with one or both of the following species.

Stelopolybia areata Say. Yellow-jackets; 1948—June 6 (1, 48709), 15 (235 counted, passing steadily), 17 (Hundreds, all morning), 18 (Steady stream), 19 (2, 48802; 150 in 2 hours), 28 (Hundreds fighting wind); July 5 (Hundreds, as during past weeks), 7 (2, 481108), 16 (2, 481208; Greatest numbers yet, thousands).

Gymnopolybia panamensis Cam. Black Wasp; Another very abundant migrant throughout June and July, usually singly, occasionally in small swarms. Almost no day without taking or seeing them. They frequently alighted on leaves at the pass. 1948—June 7 (1, 48769; several small swarms), 15 (1, 48804; 7 on leaves, fifty-odd circling or flying directly south), 24 (3, 48912, 48913, 48914; many singly); July 3 (1, 481037; 3 others caught at once), 5 (1, 481086), 7 (2, 481311, 481312), 29 (1, 481437).

Polybia liliacea F. Orange-figured-thorax Wasp; 1948—July 16 (1, 481217). Taken on five other occasions.

Large Buff-band-winged Hornet; 1948—July 2 (1, 481310), 16 (3, 481207; 4 others seen singly), 17 (1).

Hieroglyphic Hornet; 1946—March 5 (2, 46216; 21 others counted flying slowly around pass before heading south). 1948—May 5 (1, 48570; 42 others driven by high wind, down to bushes).

Various Vespidae; 1946—August 31 (1, 46995). 1948—June 6 (1, 48702); July 9 (1, 481133; 9 others taken in the same sweep of the net), 16 (1, 481209), 16 (1, 481213).

Apoidea.

Some twenty species of this superfamily were taken migrating through the pass. Several were very numerous, but none abundant. At no time, throughout many observations scattered over two years, did I record a single bee returning northward through the pass. Yet many of the euglossids and other bees were carrying loads of fresh or dried pollen. This is another of the many confusing problems presented by this mass emigration. For the nomenclature of the superfamily Apoidea I have to thank Dr. Herbert F. Schwarz.

Anthrophoridae.

Chalepogenus xanthapis Cockerell. 1948—June 6 (1, 48703, female), 22 (1, 48874, female).

Epicharis rustica (Olivier). 1948—July 16 (1, 481215A, female).

Hemisia denudans. 1948—June 19 (1, 48760, female; about 30 passed in two hours).

Hemisia labrosa Friese. 1948—June 19 (1, 48862; several others caught in same net).

Hemisia sp. 1948—June 19 (1, 48852).

Apidae.

Apis mellifera Linn. 1948—July 16 (3, 481205). Honeybees were abundant on the summit of the pass on this date, fighting the high wind. Although they were headed southwards this must have been due to the meterological conditions, and cannot be recognized as an isolated example of migration.

Bombidae.

Bombus niger Franklin. 1946—May 10 (1, 461239; taken on many other occasions). 1948—June 22 (1, 48875; taken singly on many days); July 3 (1, 481047).

Bombus robustus Smith. 1948—July 18 (1, 481249).

Bombus volucelloides Gribodo. 1948—July 5 (1, 481071), 13 (1, 481415). Taken several times; appears to be a common migrant.

Colletidae.

Colletes sp. 1948—July 4 (1, 481060, female).

Ptiloglossa mayarum Cockerell. 1948—March 13 (1, 481416).

Euglossidae.

Aglae caerulea Lepeletier. 1948—July 17 (1, 481242; not uncommon, flying singly through the pass).

Euglossa boliviensis Friese. 1948—June 19 (1, 48850; many seen passing).

Euglossa buchwaldi Friese. 1948—July 16 (1, 481215).

Euglossa dimidiata (Fabr.). 1948—June 19 (1, 48851; others seen); July 7 (1, 481106, male).

Euglossa dimidiata, var. *flavescens* Friese. 1948—March 26 (1, male); June 7 (1, 48762; 18 others seen).

Euglossa fasciata Lepel. 1946—April 30 (1, 46407). 1948—July 16 (1, 481216, female).

Euglossa magretti Friese. 1946—September 1 (1, 461110, male).

Euglossa smaragdina Perty. 1948—June 7 (1, 48763; plus 26 seen), 12 (1, 48789), 19 (1, 48849; a common migrant).

Euglossa viridissima Friese. 1946—May 8 (1, 461240, female).

Euglossa sp. 1946—July 23 (1, 461241).

Exaerte frontalis (Guérin). 1946—May 9 (1, 461099).

MEGACHILIDAE.

Megachile colombiana Mitchell. 1946—June 22 (1, 461242).

MELIPONIDAE.

Melipona fasciata indecisa Cockerell. 1946—March 6 (1, 461243). 1948—June 26 (1, 48965).

Melipona fasciata var. 1946—May 11 (1, 461244). ("Virgin queen. This is possibly the undescribed queen of *indecisa*." Herbert F. Schwarz).

Trigona amalthea (Olivier). 1946—May 27 (1, 461245).

Trigona fulviventris Guérin. 1946—February 26 (1), March 7 (1), March 13 (1), March 16 (2), May 29 (1),; June 20 (1). 1948—June 24 (1, 48915; many resting on leaves); July 2 (1, 481316), July 16 (1, 481212).

Trigona testacea cupira Smith. 1946—May 7 (2, 461246).

Trigona trinidadensis Provancher. 1948—June 6 (1, 48698), 6 (1, 48701, male), 15 (1, 48799); July 16 (1, 481211).

XYLOCOPIDAE.

Xylocopa brasilianarum Linn. 1948—June 19 (1, 48853, male; 25 others seen).

Xylocopa frontalis trinitatis Cockerell. 1948—July 7 (1, 481105, female; not rare).

21.

A New Fish of the Genus *Gambusia* from Southern Veracruz, Mexico, with a Discussion of the Tribe Gambusiini Hubbs.

DONN ERIC ROSEN & MYRON GORDON.

New York Aquarium, New York Zoological Society.[1]

(Text-figures 1-8).

On a New York Zoological Society expedition in March of 1948, Myron Gordon, James W. Atz and F. G. Wood, Jr., made extensive collections of the freshwater fishes of the Atlantic slope of southern Mexico. Among these is a new poeciliid belonging to the genus *Gambusia* Poey of the tribe Gambusiini Hubbs. A diagnostic description follows.

Gambusia atzi, new species.

Type specimens. The holotype, deposited at the University of Michigan Museum of Zoology, cat. no. 167098, is an adult male 23.50 mm. in standard length, collected by James W. Atz and F. G. Wood, Jr., on March 5, 1948. Together with the holotype, 46 paratypes were obtained (UMMZ 167099) which range in size from 20.50 to 23.50 mm. for the adult males, and from 22.25 to 31.00 mm. for the adult females. Among the paratypes, 10 males, 19 females and 17 immature forms were collected. All 10 male paratypes are fully mature and each has a perfectly formed gonopodium.

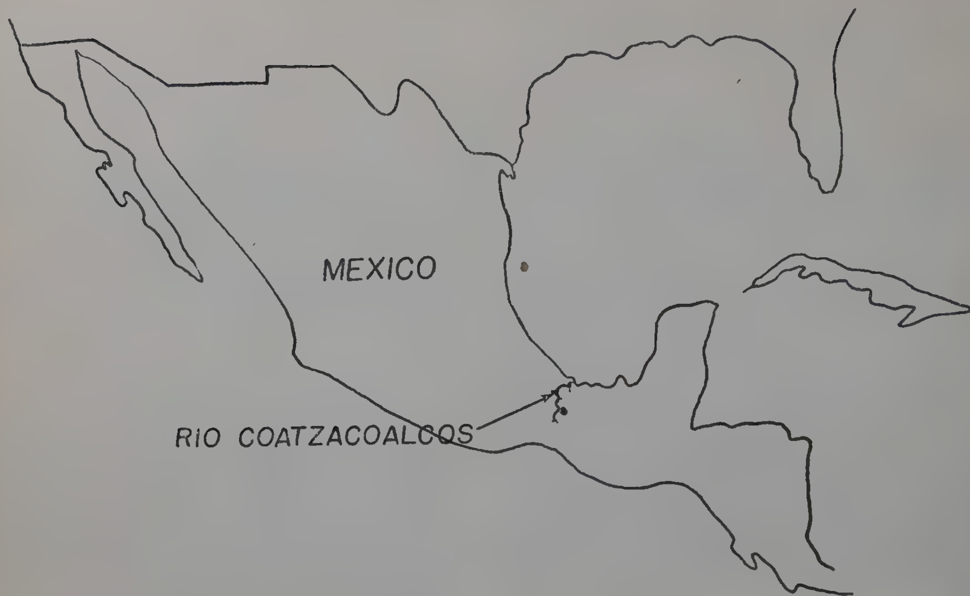
Type locality. "Laguna de la Sapote," about one kilometer northwest of Jesus Carranza, Veracruz (Text-fig. 1). The waters of the Laguna are continuous with the Río Jaltepec which is part of the Coatzacoalcos drainage system. Fishes were found along the shore waters in coarse grass. The bottom of the Laguna consisted of mud overlying clay.

Additional specimens were collected in the Arroyo Santiago Vasques, which also drains into the Río Jaltepec at Jesus Carranza. The water of this stream was partially opaque and its banks were overhung with a thick jungle flora. Specimens were also seined from a stream running into the Arroyo Santa Lucrecia, about 700 meters from its confluence with the Río Jaltepec at Jesus Carranza. As before, jungle growth overhung the stream-bed and the bottom was clay with some gravel.

Diagnosis. On the basis of gonopodial and other details, this species is definitely a member of the tribe Gambusiini Hubbs. Of the two genera in this tribe, *Belonesox* Kner and *Gambusia* Poey, it clearly enters the latter. It resembles the other members of the genus *Gambusia* in having a distinctly fusiform body with the dorsal fin placed far posteriorly on the body. Like other gambusiins, it has a typically long and slender gonopodium originating somewhat behind the level of the base of the pectoral fin. This species differs from other members of the genus principally as follows: it is more fusiform; the trailing edge of its dorsal fin almost reaches the base of its caudal (Text-fig. 2); many of its gonopodial details deviate significantly. For example, the claws on rays 4p and 5a of the gonopodium are much reduced, and the elbow on ray 4a is large, with a strong retrorse curve. In addition, the pronounced buckling of the subdistal elements of rays 4a and 4p constitutes a positive means of distinguishing *G. atzi* from the other members of the genus (see Description, below).

Description. In the gonopodium (Text-fig. 3), the primary and secondary claws (at the tips of rays 4p and 5a) are small, almost rudimentary; in this respect they are similar to the claws in the gonopodium of *Belonesox belizanus* Kner (Text-fig. 4). A series of 7 to 8 high and irregularly rectangular segments follow the claw on ray 5a. The segments of ray 5p, which constitute the lateral margins of the spoon, are serrate along their free edges and generally have two denticles each. The subterminal segments immediately proximal to the primary claw of ray 4p, usually 5 in number, are long and thin, especially distally; the 4 segments between them and the proximal serrae are without definite form, but resemble irregular discs. There are 6 to 8 proximal serrae, the last members usually having a common base. The tip of ray 4a originates proximal to the primary claw, at the level of the first subterminal segment of ray 4p; it extends proximally as a uniform series of 5 slender elements which are associated with another series of discoidal segments, 4 or 5 in number. These latter elements are followed by three stout rectangular segments which join the elbow. The irregular, discoidal segments of this ray form an open-S together with their distal and proximal serial homologs, producing a curious buckle in the ray. The buckling of ray 4a is a constant feature of all the gono-

[1] From the Genetics Laboratory of the New York Zoological Society at the American Museum of Natural History, New York 24, N. Y. Aided in part by a grant from the American Philosophical Society.



TEXT-FIG. 1. Type locality of *Gambusia atzi*. The small dot near the Río Coatzacoalcos represents Jesus Carranza (Santa Lucrecia), Veracruz, Mexico.

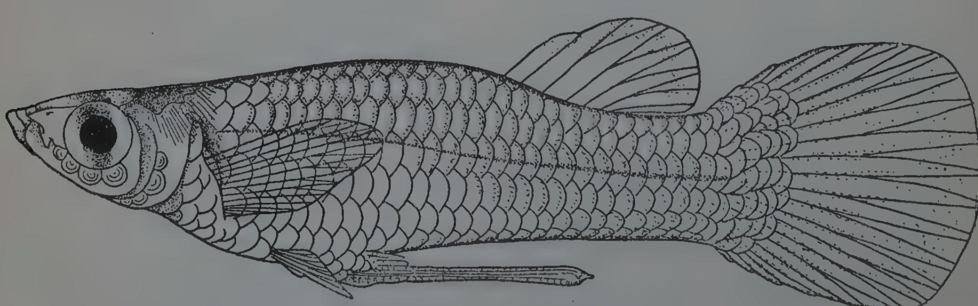
podia examined. The elbow on the same ray is quite large, larger than in any other gambusiin species. It is the largest single structure in the gonopodium of this species, and its anterior projection has a strong retrorse curve. Rays 4a and 4p are completely fused just behind the level of the elbow.

The tip of ray 3 is reduced, originating behind the tip of ray 4a. The terminal segment is long and slender, followed by a series of 11 to 13 short spines. The shafts of the distal spines curve proximally, but the major extension is an anterior one. In general, ray 3 curves sharply posteriorly at its tip. The terminal segment of ray 3 lies close to and occasionally overlaps the distal segments of ray 4a. The pronounced subdistal curvature of the tip of ray 3 and the staggered distribution of the tips of rays 4p, 4a and 3 produce a concavity on the anterior margin of the tip of the gonopodium (Text-fig. 3).

Number of scales along mid-lateral line: 26 to 29, most often 28. Number of scale rows along side, at the level of the anus (level of greatest depth): 6½ to 7. Dorsal fin rays, counting the last 2 rays as one: 6, rarely 7. Pelvic fins of both sexes short, 7 times into the standard length. Depth about 4 times into standard length. The premaxillary in both sexes is broad and flat. Lower jaw projecting up obliquely at a sharp angle. Gape of mouth wide.

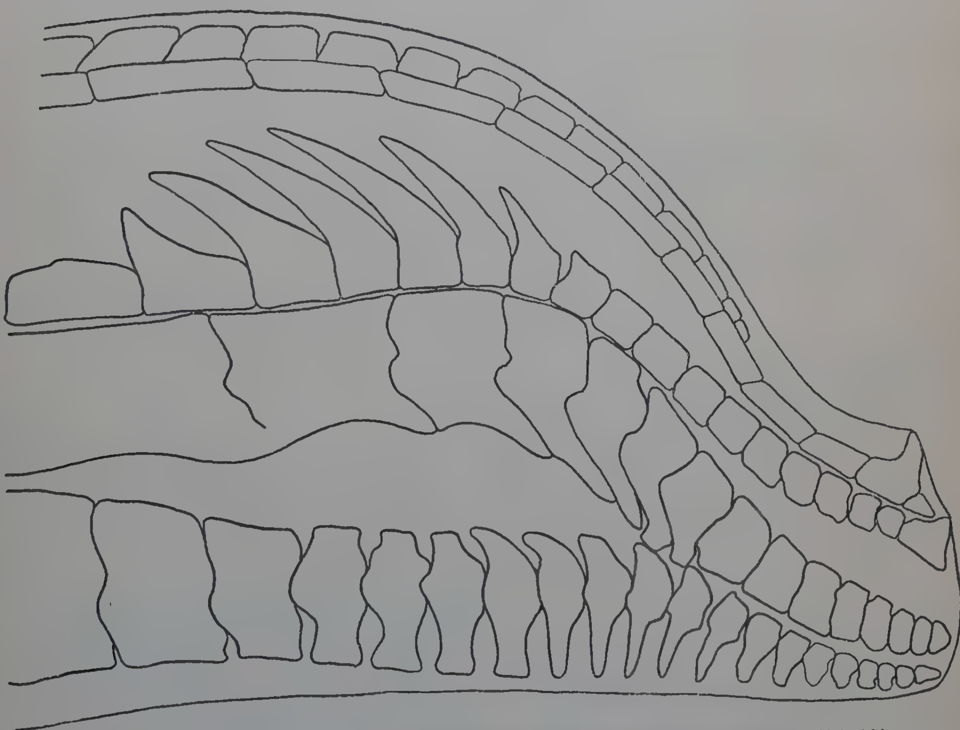
The coloration of *G. atzi* is quite constant, differing slightly but significantly from the coloration of other members of the tribe. It is yellowish-brown in alcohol. A thin but well-defined lateral streak extends from the base of the hypural to the base of the pectoral fin. Edges of scale pockets finely dotted with melanophores; they produce a faint dusky and variegated appearance. There is no other regular or irregular spotting on sides. One of the striking features of the coloration of this new species is as follows: A dark line runs along the entire dorsal margin and ends anteriorly in a heavily pigmented area above the supraoccipital. There is a dark line on the ventral margin of the caudal peduncle, which ends abruptly at the base of the gonopodium. All fins are faintly stippled with melanophores.

Relationships. The members of the tribe



TEXT-FIG. 2. Diagnostic drawing of a male of *Gambusia atzi* (× 6).

TEXT-FIG. 3. Distal tip of the gonopodium of *Gambusia atzi* (× 50).

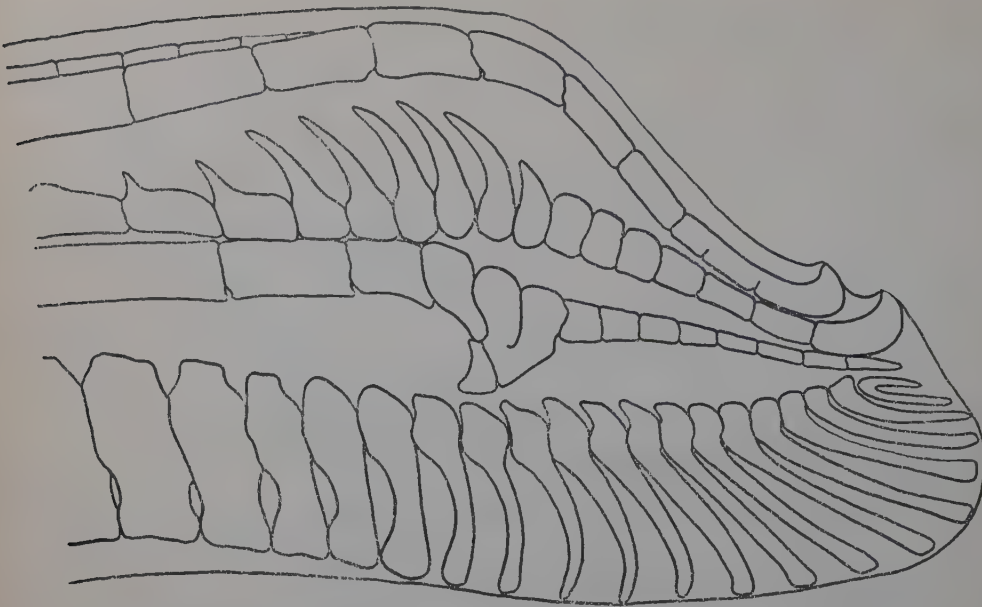


TEXT-FIG. 4. Distal tip of the gonopodium of *Belonesox belizanus* (× 40).

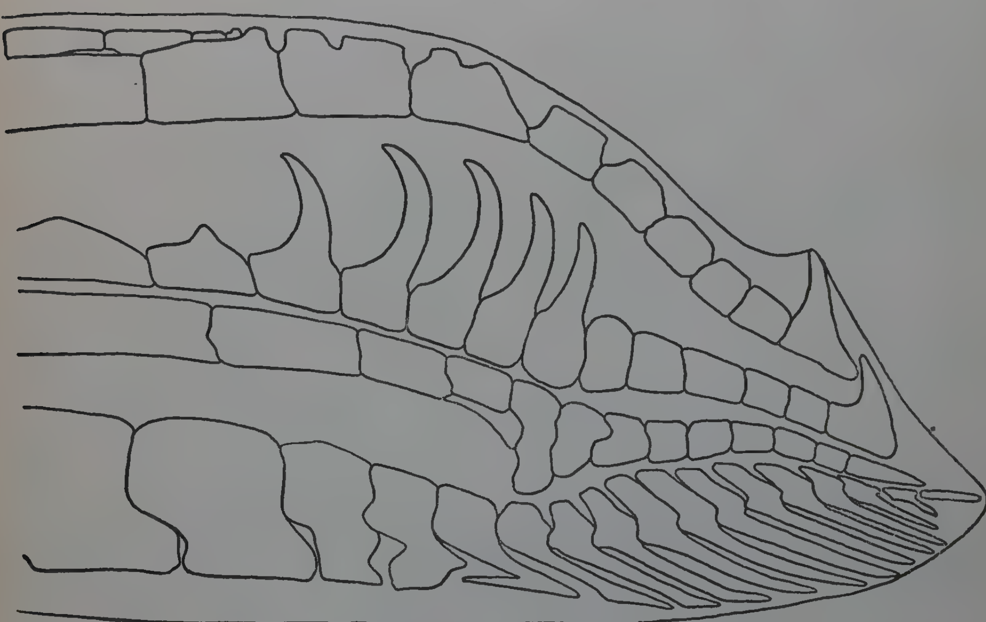
Gambusiini are among the most ubiquitous of all poeciliid fishes. They are found throughout the eastern, central and southwestern United States, Mexico and Central America, the Lesser and Greater Antilles and the Bahamas. Beyond this extensive range, a species, *Gambusia lemaitrei* Fowler (1950), has recently been described from Colombia. But despite their great range, they constitute a remarkably uniform group of fishes, the only notable exception being *Belonesox belizanus* Kner. Nevertheless, many species and subspecies have been recognized by some workers. The precise nature of the relationships among the various members of the group remains in doubt.

Hubbs (1926) placed *Belonesox* Kner and *Gambusia* Poey in the tribe Gambusiini Hubbs. He subdivided *Gambusia* into four subgenera largely on the basis of distinctions in gonopodial morphology. These subgenera are:

Heterophallina.
Gambusia.
Arthrophallus.
Schizophallus.



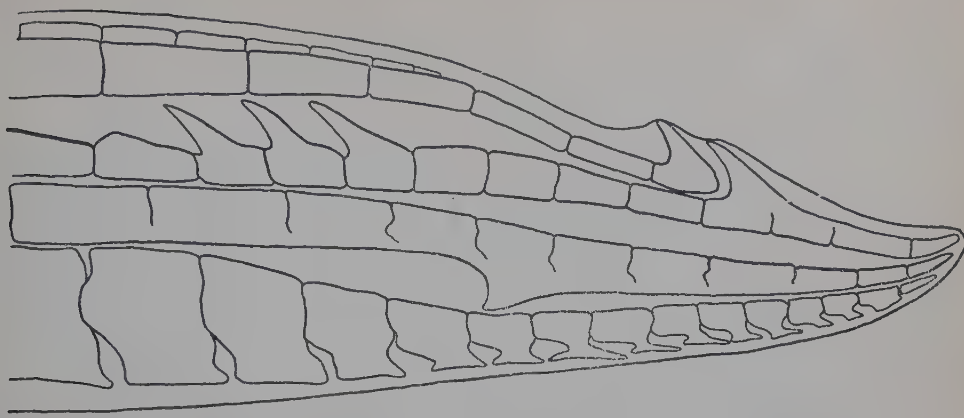
TEXT-FIG. 5. Distal tip of the gonopodium of *Gambusia panuco* (× 50).



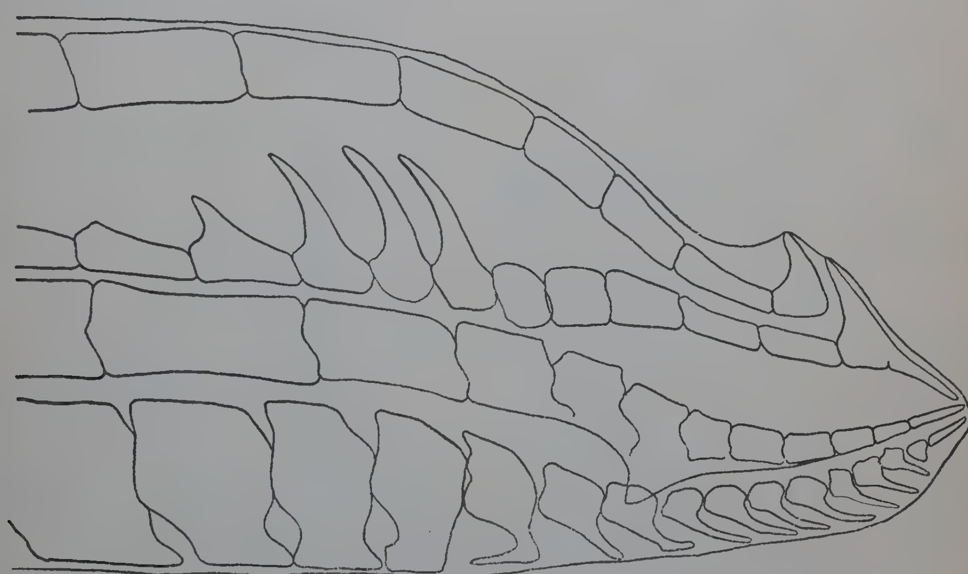
TEXT-FIG. 6. Distal tip of the gonopodium of *Gambusia nicaraguensis* (× 50).

The subgenus *Heterophallina* includes three species, *G. regani* Hubbs, *G. vittata* Hubbs and *G. panuco* Hubbs. The last has been studied intensively by Rosen (unpublished), who notes that the gonopodium of *G. panuco* may be distinguished from those of other gambusiins by the presence of reduced and curvilinear claws and long, slender, finger-like spines (Text-fig. 5).

Hubbs listed twelve species in the subgenus *Gambusia* which, among others, include *G. affinis* Baird & Girard, and *G. nicaraguensis* Günther. With reference to a host of diagnostic characters, particularly those in the gonopodia, these two species are quite different. *G. nicaraguensis* is a stout fish, heavily marked with characteristic melanophore spotting, especially on the dorsal and caudal fins. Its gonopodium contains short, high claws and long, slender antrorse spines (Text-fig. 6). *G. affinis* is a far more slender fish with significantly less regular spotting.



TEXT-FIG. 7. Distal tip of the gonopodium of *Gambusia affinis* (× 50).



TEXT-FIG. 8. Distal tip of the gonopodium of *Gambusia dominicensis* (× 50).

Its gonopodium contains shorter claws and severely reduced and specialized spines (Text-fig. 7). Krumholz (1948) pointed out that the nominal species *G. affinis*, included in the subgenus *Gambusia* by Hubbs (1926), should actually be referred to *G. senilis* Girard, described by Regan (1913) and Geiser (1923). The true *G. affinis* is quite distinct, while the morphological details of *G. senilis* are closely similar to those of *G. nicaraguensis*. An additional species *G. dominicensis* Regan, also included in the subgenus *Gambusia*, is similar to the true *G. affinis* in many of its morphological details (Text-fig. 8).

The remaining two subgenera, *Arthrophallus* Hubbs and *Schizophallus* Hubbs, include species which have generally been regarded as belonging to the "*G. affinis* complex." They are *G. patruelis* Baird & Girard (*Arthrophallus*) and *G. holbrooki* Girard (*Schizophallus*). Geiser (1923) suggested that the form discussed as *G. patruelis* by Regan (1913) is so close to *G. affinis* in many of its structural details that it should be dropped into synonomy with the latter. This point of view has been shared by other workers. Geiser also indicated that the eastern representative of the *G. affinis* group should be treated as a distinct species, *G. holbrooki*, implying, however, that it is quite close to *G. affinis* and not deserving of more than specific rank. The subgenus *Schizophallus* containing the species *G. holbrooki* was based apparently upon an anomalous specimen or specimens by Hubbs (1926). More recently the subgenus *Schizophallus* has been abandoned by Hubbs and *G. holbrooki* is generally recognized today as being very closely allied to *G. affinis*. Krumholz (1948), in his review of some of the literature, states that Hubbs & Walker (unpublished) recognize only a single species, *G. affinis*, for which three subspecies may be

named: *G. a. affinis, G. a. holbrooki* and *G. a. speciosa.* That the gambusiins found in the United States, with the exception of *G. senilis,* are closely related and probably only subspecifically different is confirmed by Haskins & Rosen (unpublished). They show, together with Geiser (1923) and Hubbs & Walker (unpublished), that the fishes of the eastern-most fringe of the range of *Gambusia* intergrade with those of the central and southwestern United States.

Within the Gambusiini there are five basic gonopodial types which are represented by "species groups". These groups have definite ranges for the most part:

1. The *G. affinis* type occupies the eastern, central and southwestern United States.
2. The *G. panuco* type is largely restricted to northern Mexico.
3. *G. nicaraguensis* and related forms are found in Mexico, Central America, the Antilles and the Bahaman Islands.
4. *Belonesox belizanus,* in general, shares the mainland distribution of the *G. nicaraguensis* complex.
5. *G. atzi* is localized at the southern tip of Veracruz. It occurs sympatrically with *G. nicaraguensis* and *Belonesox belizanus.*

This new species is quite distinct from other known Gambusiini with reference to its gonopodial details. Its particular complex of genitalic elements does not fit within the framework of the subgeneric characters as indicated by Hubbs (1926) or into any other specific group of systematic characters now known. The discovery of this new species emphasizes the need for a revision of the entire Gambusiini.

This species is named for James W. Atz, Assistant Curator, New York Aquarium, New York Zoological Society, in recognition of his energetic work in collecting this and many other species of Mexican fishes.

Acknowledgments.

We wish to thank Dr. Robert Rush Miller, Museum of Zoology, University of Michigan, for his help in the preparation of the manuscript, and Dr. C. M. Breder, Jr., of the American Museum of Natural History for his suggestions. We also thank the American Museum of Natural History for use of their laboratory facilities.

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22.

Epidermal Fin Tumors in the Gobiid Fish, *Bathygobius soporator.*

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(Plates I-V).

In their excellent review of the literature on neoplasias in cold-blooded vertebrates, Schlumberger & Lucké (1948) list thirteen reports of epitheliomas in fishes. Of these only one case involved the fins (Fiebiger, 1909), and the majority were epitheliomas of the lips or the oral mucosa.

In a collection of approximately 150 specimens of *Bathygobius soporator* (Cuvier & Valenciennes), three individuals were found to possess fin tumors of epidermal origin. The animals were collected in the vicinity of the Lerner Marine Laboratory, Bimini Island, B. W. I., during the months of July and August, 1949. A fourth tumorous specimen was sent to the writer by Dr. E. F. B. Fries, who collected it at the same locality in December, 1949.

Since the tumors in *Bathygobius* were found to be invasive and destructive of normal tissues, and since occurrence of epitheliomas in fishes has been infrequently described, the present report was undertaken.

The writer is indebted to the staff and facilities of the Lerner Marine Laboratory, Bimini Island, B. W. I., for the opportunity to collect and utilize this material. Dr. Ross F. Nigrelli, of the New York Aquarium, New York Zoological Society, kindly read and commented on the manuscript. The writer is also grateful to Dr. Eric F. B. Fries, of The City College, for one of the specimens used in this report.

Gross Morphology of the Tumors.

For purposes of reference in this paper, the three tumorous individuals collected by the writer will be designated as "A," "B" and "C." The fourth specimen, collected by Dr. Fries, will be referred to as "D."

The sexes of the above animals were not determined, but, judging from their size, they may be presumed to have been sexually mature. They ranged from 6 to 7 cm. in standard length. During the time they were kept in the laboratory (about two weeks), they exhibited normal swimming and feeding behavior, and no function appeared impaired by the presence of the tumors on the fins.

The tumors all involve the fins and in each case more than one tumor is present. The growths are of different sizes and of varying degrees of invasiveness, so that they may be tentatively grouped in three classes on the basis of external, macroscopic appearance. A total of 12 tumors was examined.

1. The smallest tumors are visible as thickenings of the membranes at the distal ends of fin rays. The affected rays are slightly shortened and the membranes appear whitish and opaque. Five tumors of this type were found on three of the specimens examined.

2. The next stage of tumor formation appears as a distinct swelling of the epidermis into a rounded lump of tissue, colored light gray or white in life. Such overgrowths are small, covering an area of up to 4 sq. mm., and protruding about 0.3 to 0.5 mm. from the surface. The distal portions of several fin rays may be covered. Five tumors of this type were identified.

3. The largest tumors show considerable overgrowth, as well as complete destruction of the affected fin or portion of the fin. A compact, smooth-surfaced mass may be formed, or the surface may be rough and reddened. Two examples of these tumors were studied.

Following is a description of the tumors in the four specimens examined:

Specimen A.

Ventral Fins: These fins are normally fused into a single, median, sucker-like structure. In this specimen, the ventral fins are completely replaced by an irregular, lobed mass of tumor tissue (type 3, see above), measuring about 4 by 5 mm., and protruding about 2 mm. from the body. The surface of the tumor is rough and reddened.

Pectoral Fins: The ventral margins of both pectorals exhibit a visibly thickened epidermis covering the terminal portions of the four most ventral rays. An area of about 1 by 1.5 mm. is covered by these type 1 growths.

Caudal Fin: A tumor (type 2) covers the ends of the four most ventral rays. A slight overgrowth, 0.3 mm. in thickness, is present.

Specimen B.

Dorsal Fins: The anterior margin of each dorsal fin possesses a small, irregular, smooth-surfaced tumorous overgrowth, measuring approximately 1.5 mm. in diameter and 0.4 mm. in thickness (type 2 tumors). An epidermal thickening extends from each of these tumors distally and posteriorly over the first three spines of the anterior dorsal fin, and the first two rays of the posterior fin.

Left Pectoral Fin: The apex of the left pectoral fin shows a thickening over the distal 4 mm. of the five central, longest rays. An overgrowth (type 2), 2 mm. in diameter and 0.5 mm. in thickness, is present at the center of this area. Only the outer surface of the fin is affected.

Specimen C.

Pectoral Fins: Both pectorals exhibit tumors of type 1. The left pectoral possesses a thickened epidermis covering the five ventral rays. The right pectoral has a slight thickening at the apex, involving the distal 2 mm. of the two longest rays.

Specimen D.

Right Pectoral Fin: In the genus *Bathygobius*, the dorsal-most 5 to 8 fin rays are highly branched and lack a connecting membrane, forming a silk-like fringe of free rays. In this specimen, these free rays have been completely replaced on the right side by a compact, ovoid tumor, measuring 3 mm. in length, 0.8 mm. in width, and 1.7 mm. in depth (type 3 tumor). The tumor possesses a smooth surface and is attached at the dorsal margin of the base of the fin. An area of thickened epidermis extends ventrad over the bases of the two next fin rays.

Left Pectoral Fin: The ventral margin shows a slight epidermal thickening (type 1) covering an area of about 1 mm. by 1.5 mm.

Ventral Fins: The entire posterior margin of the fused ventral fins possesses a thickened epidermis. The fin rays appear slightly shortened. Three small overgrowths, each 0.7 mm. in diameter and 0.3 mm. in thickness, are present at the ends of three of the longest rays. These may be considered collectively as a type 2 tumor.

Histology of the Tumors.

For histological study, specimens A and B were fixed in Bouin's picro-formol, the others in 10% formalin. The fins were sectioned at 8 microns and stained with Harris' hematoxylin and eosin, or with a modified Masson trichrome technique. A red filter (Wratten A) was used for some of the photographs to bring out the blue-stained connective tissue and basement membranes produced by the latter technique. A green filter (Wratten B) was used for the rest of the photographs.

Normal Fin Epidermis (Figs. 1 & 2).

Over most of the surface of the fins, the epidermis varies from 40 to 70 microns in thickness, and consists of 10 to 20 layers of cells (Fig. 1). The outermost two or three layers are composed of squamous cells many of which are pycnotic (Fig. 2). Occasional gland cells are present here. Beneath the surface, the cells become less flattened, measuring 4 to 6 microns in thickness and 10 to 15 microns in width. The major thickness of the epidermis is composed of these cells. The basal portion of the epidermis consists of one or two layers of narrow columnar cells, ranging from 8 to 12 microns in height and 3 to 4 microns in width. A distinct basement membrane is present and a subjacent narrow, collagenous *stratum compactum* of the dermis. The latter is never more than 5 microns in thickness. The junction of the epidermis and the dermis forms a smooth or finely crenated margin.

The interior of the fin contains the fin rays, blood vessels, etc., within a loose connective tissue network. Muscle bundles are present beside each fin ray toward the base of the fin.

Type 1 *Tumors* (Figs. 3, 4, 8).

Macroscopically these growths appear as thickenings and opacities of the fin membrane; and histologically they are areas of epidermal hyperplasia with little or no invasion of subjacent tissues. Such a condition is found on the pectoral fins of specimens A and C and the left pectoral fin of Specimen D. The same type of hyperplasia is present around the margins of the type 2 and 3 tumors, where it gradates into the surrounding normal epidermal structure.

The hyperplastic epidermis varies from 70 up to 250 microns in thickness, and consists of 40 to more than 100 layers of cells (Fig. 3). The surface layers are similar to those of the normal epidermis, consisting of a few layers of squamous cells and occasional gland cells (Fig. 3). The surface, however, is irregular and wrinkled, with some of the cells cuboidal in shape. The basal layers are long columnar in the thinner regions and become cuboidal and more densely packed where the epidermis is thickest (Fig. 8). The major volume of the epidermis is composed of irregular polygonal cells 8 to 10 microns in size, with distinct cell membranes and clear cytoplasm (Fig. 4). The line of junction of the basal layers and the *stratum compactum* of the dermis is continuous but highly irregular, forming blunt indentations into the subjacent tissues (Fig. 3).

Type 2 *Tumors* (Figs. 7, 9, 10, 11).

These tumors represent the first stages of true invasion and overgrowth. They are present on the caudal fin of specimen A, the dorsals and left pectoral of specimen B (Fig. 7), and the ventral fin of specimen D.

A distinct surface coat is present, consisting of 3 to 5 layers of closely packed cuboidal cells (Fig. 10). The cells range from 4 to 8 microns in size. Few of these cells appear pycnotic or sloughing, and the entire

surface of the tumor is smoothly rounded. No gland cells were observed here.

A loose region is present beneath the surface coat, ranging from 20 to 90 microns in thickness (Figs. 9, 10). Most of the cells here are stellate in shape, and considerable intercellular space is visible. Some polygonal forms and larger vacuolated cells are present. These measure about 8 and 12 microns, respectively. The Masson trichrome stain showed no connective tissue fibers in this region.

The main mass of the tumor is derived from the basal layers. Epithelial pegs penetrate the *stratum compactum*, the subcutis and other internal fin structures (Fig. 9). At the points of penetration the pegs vary from 30 to 100 microns in thickness and are composed of densely packed cuboidal or polygonal cells averaging 5 microns in width (Fig. 11). The cores of the largest pegs possess small groups of 40 or 50 cells arranged in irregular circular masses. These groups may be classified as early stages in pearl formation.

Within the interior of the fin, the epithelial pegs ramify and send branches into muscle fascicles, around and between the lepidotrichia (Fig. 11). The center of the fin is swollen by the aggregation of the invading epithelial cords (Figs. 7, 9). Some of the pegs reach across to the opposite surface, the epidermis of which shows no signs of hyperplasia. In the center of the invaded region the muscle bundles are completely destroyed, but the fin rays are all intact (Fig. 11).

The invading cords possess a distinct basement membrane and a thin surrounding coat of collagenous fibers. Small blood vessels are present in the interstices between the network of cords (Figs. 9, 11).

Type 3 Tumors.

These tumors are characterized by extensive overgrowth and destruction of normal tissues. The two examples found differ somewhat from each other in structure, and therefore their histology will be described separately.

Right Pectoral Fin Tumor
of Specimen D (Fig. 6):

This growth forms a compact nodule attached to the dorsal, basal portion of the fin. The free pectoral rays are completely destroyed and the bases of the next two fin rays are invaded and their muscles destroyed. In cross-section, the tumor measures 0.8 mm. in width and 1.7 mm. in height, with the major portion consisting of an interwoven mass of epithelial pegs.

A surface coat of mixed cuboidal and squamous cells forms a smooth covering. One to five layers of these cells may be present. No gland cells are evident.

In the interstices of the complex meshwork of epithelial cords, numerous capillaries and small amounts of loose collagenous tissue are found. Capillaries are more numerous toward the surface of the tumor and are found within a tissue which appears similar to the sub-surface layer of polygonal, vacuolated or stellate cells described for the tumors of type 2.

Occasional incipient pearl formations are present within the centers of some of the epithelial cords. The pearls vary from 40 to 70 microns in diameter. Each pearl consists of a compact center of 10 to 40 polygonal cells. The cells average 3 to 5 microns in width, and the cores vary from 10 to 20 microns in diameter. Surrounding this core are 2 to 4 layers of tightly packed squamous cells and a loose area of irregularly concentric squamous and stellate cells.

Within the central mass of the tumor, the epithelial cords are so irregular and tightly packed that no average measurements can be given. They are similar in structure to those of the tumors of type 2, but basement membranes can be found only rarely. Toward the base, the tumor structure resembles that of type 2 more closely. A thickened epidermis and epithelial pegs invading the dermis and subcutis are present.

The fin rays below the base of the tumor are intact but the muscle associated with two of these rays is invaded or destroyed, in part, by invading tumor cords. Only the two rays just ventral to the tumor are so affected. Further ventrad, the epidermis over the next fin rays is thickened and possesses a structure like that of the tumors of type 1. No multi-nucleate, "giant" cells are found in this tumor.

Ventral Fin Tumor
of Specimen A (Figs. 5, 12-19):

This tumor is the largest and most invasive of all those studied. As described previously, the entire ventral fin complex is replaced by the growth.

In microscopic structure, this tumor is less compact and more vascularized than the one described from specimen D (Fig. 5). Numerous capillaries and sinusoids are present between the epithelial cords. Some of the sinusoids reach a diameter of 35 microns, while most of the smaller vessels are under 15 microns in width (Fig. 12).

An irregular surface coat of several layers of cuboidal cells covers the median ventral surface (Fig. 14). The surface coat is thinner, smoother, and composed of squamous cells toward the sides of the tumor. Some of the blood vessels are ruptured near the ventral median surface, and blood cells, along with surface epithelium, are found sloughing off in irregular masses of up to 60 to 100 cells. No gland cells are present.

Beneath the surface coat, there is a region of numerous small blood vessels, many of which are ruptured, and erythrocytes are visible within the loose meshwork of tumor tissue (Fig. 14). Although intact blood vessels exhibit some collagen at their surface, no collagenous fibers are found within this loose meshwork of cells. Some of the vessels contain numerous lymphocytes as well as

erythrocytes, but few lymphocytes or macrophages can be identified extravascularly.

Several large fluid-filled vesicles are present near the periphery of the tumor (Figs. 5, 13). These vary from 50 to 150 microns in diameter, and in each case a blood vessel is present in the center of these structures. The space around the blood vessel contains a loose granular network of precipitated material and a scattering of lymphocytes. Incipient vesicles may be found around many of the peripheral blood vessels and it is probable that they are edematous cysts formed by extravasation of blood fluids.

The major portion of the tumor consists of epithelial cords which form a less compactly interwoven mass than in the tumor of specimen D (Figs. 5, 12, 13). Many of the cords run parallel to each other, extending into the base of the tumor around the remnants of fin rays. The cords vary in size from narrow acuminate ones of 20 microns in width (Fig. 16), to broad, rounded shapes of up to 100 microns in width (Fig. 15). The centers of many of the cords contain incipient pearl formations (Figs. 18, 19) similar to those described for the tumor of specimen D above.

The surface of the cords possesses a 2- or 3-layered coat of cuboidal cells (Figs. 15, 16). These cells are about 3 to 5 microns in width, compactly arranged, and exhibit numerous mitotic figures. The cells in the centers of the cords are more loosely packed and frequently resemble mesenchymal cells in shape.

The basement membrane is distinct and continuous around most of the epithelial cords, but the ends of some show a breakdown of this membrane (Figs. 16, 17). This type of "flame" structure is present predominantly toward the base of the tumor and around the remnants of fin rays. The cells from these "flame" formations fan out and become stellate in shape (Fig. 17). How extensive a migration of these cells takes place is unknown. No evidence of metastasis was found on the fins in the vicinity of the tumors.

No multi-nucleate, "giant" cells can be identified in this or any of the previously described tumors.

Discussion.

Little is known of the actual genesis of the fin tumors of *Bathygobius*, but with the material thus far available, a sequence of the probable stages of growth of these neoplasms can be inferred. It is not known whether the tumors of type 1, which are simply epidermal hyperplasias, would, if given time, advance to type 2 or 3. Since the margins of the larger tumors are surrounded by such hyperplastic epidermis, however, it is probable that the growths arose from initial stages which were similar in structure to the tumors of type 1.

There are several characteristics of these tumors of *Bathygobius* which permit them to be allocated to the class of epitheliomas or epidermoid carcinomas. Chiefly, there is the formation of invading epithelial pegs and the destruction of fin rays and muscles. This was found in the tumors of type 2 and type 3. In the latter, there are areas where the basement membrane of the cords becomes broken down and flaring "flame" processes are formed. Such cords and flaring structures were considered as criteria of malignancy by Lucké & Schlumberger (1941) and Schlumberger & Lucké (1948), for lip epitheliomas in catfish (*Ameiurus nebulosus*).

Incipient pearl formation within the epithelial cords is present in both epitheliomas and papillomas of fishes. As pointed out by Schlumberger & Lucké (1948), true pearls cannot be formed in fish tumors since keratinization does not take place in the piscine integument. However, the presence of such incipient pearls is indicative of the resemblance of fish carcinomata to those of mammals.

Both pearl formations and epithelial cords have been reported as characteristics of epitheliomas in fishes, but with regard to other histological characteristics considerable variation exists from species to species.

In most cases the epithelial cords penetrate and destroy subjacent muscle and skeletal tissues. Johnstone (1923) described a tumor of the lower jaw of the whiting (*Merlangus merlangus*) which invaded a large portion of the mandible. Multiple tumors are also common, and as an extreme case, Christiansen & Jensen (1947) described multiple carcinomata covering almost the entire body surface in eels (*Anguilla anguilla*) from Danish waters.

The tumor mass is always highly vascularized, with numerous capillaries ramifying within the connective tissue interstices between the anastomosing tumor cords. The presence of larger and more numerous vessels toward the surface of the tumors was found in the present material and has been frequently reported. Lucké & Schlumberger (1941) observed that a localized, surface hyperemia precedes the formation of a tumor on the lips of catfish and that hyperemia persists throughout the development of the epithelioma. A similar hyperemic surface condition was reported by Fiebiger (1909) for a lip tumor in the tench (*Tinca tinca*), Johnstone (1923) for the jaw tumor of the whiting, and Christiansen & Jensen (1947) in an epithelioma of the eel. In this hyperemic region, sinusoid-like vessels were found in the type 3 tumors of *Bathygobius* similar to those described by Lucké & Schlumberger (1941) for *Ameiurus* tumors.

Other than this hyperemic condition, few signs of true inflammation have been reported. Lucké & Schlumberger (1941) found cells at the base of the catfish tumors which they tentatively identified as extravasated lymphocytes, and some leucocytes were found toward the surface of the ventral fin tumor in *Bathygobius*.

The epithelioma of the whiting (Johnstone, 1923) exhibited a condition in which the epithelial cords were short, instead of long and anastomosing. The main mass of the tumor possessed little continuity with the surface epidermis and consisted of numerous, isolated pearl formations, each surrounded by a capsule of connective tissue. Pearl formations, as found in *Bathygobius* tumors, and described by Fiebiger (1909), Lucké & Schlumberger (1941), and Schlumberger & Lucké (1948), were located within the epithelial cords and were surrounded by concentrically arranged, modified epithelial cells.

Johnstone (1923) also described a fusion of cells within the pearls into multi-nucleate structures, similar to those found by Fiebiger (1909) in fin tumors of the carp (*Cyprinus carpio*). Such multi-nucleate, "giant" cells were not observed in the *Bathygobius* tumors.

In the present material, the growth of the tumor was accompanied by the disappearance of epidermal gland cells. These cells are found in the normal epidermis and the type 1 tumors in *Bathygobius*, restricted to the surface layer. In species where mucoid and clavate gland cells are more numerous and more basally located, the epitheliomas exhibit these cells within the main tumor structure, in the centers of the epithelial cords. This has been reported by Fiebiger (1909) for *Tinca*, Lucké & Schlumberger (1941), and Christiansen & Jensen (1947). Williams (1928) described an epithelioma in the cod (*Pollachius virens*) in which gland cells were extremely numerous and actively secreting within the tumor mass, forming cyst-like cavities containing mucus. This latter tumor differed from the others in the possession of a heavy connective tissue stroma, as opposed to a thin, narrow network.

True metastases have never been reported in piscine epitheliomas, nor have any been identified in the present material. Multiple tumors evidently arise spontaneously. It is not known, however, how extensive a migration of cells takes place from the "flame" processes described here and by Lucké & Schlumberger (1941). Such structures as the tumor emboli found in blood vessels of catfish epitheliomas (Lucké & Schlumberger, 1941), and isolated pearl formations (Johnstone, 1923) may possibly be involved in the spread of the tumor.

Epitheliomas in fishes are frequently associated with some region where laceration or abrasion is likely to occur. Most of the reports listed by Schlumberger & Lucké (1948) give the lips, jaws and oral mucosa as the site of the tumor. Christiansen & Jensen (1947) state that the eel epithelioma usually begins its development around the mouth or on the head, which fact they correlate with the burrowing habits of the species. The most advanced growth described here in *Bathygobius* had replaced the sucker-like ventral fins which the goby uses in attaching itself to the substrate. No evidence of any infectious agent in the etiology of these tumors has been reported. Christiansen & Jensen (1947) attempted transmission of the disease with no success. They found some correlation between temperature changes and tumor incidence. Lucké & Schlumberger (1941), although successful in transplanting tumor tissue, were not able to correlate the incidence with any etiological agent.

Summary.

Four specimens of the gobiid fish, *Bathygobius soporator* (Cuvier & Valenciennes), collected at Bimini I., B. W. I., possess abnormal epidermal growths on the fins. The tumors vary from epidermal thickenings measuring 1 mm. by 1.5 mm. in area, to irregular, lobed overgrowths protruding from the body and completely replacing normal fin structure.

The smallest tumors consist of an epidermal hyperplasia. The second stage of tumor formation exhibits some overgrowth and a penetration of subjacent tissues by epithelial cords. The largest tumors are destructive of fin rays and muscles and exhibit characteristics of epitheliomas in the possession of invasive and flaring cords, numerous mitoses and incipient pearl formations. The tumors are highly vascularized and possess sinusoid-like vessels and fluid-filled vesicles toward the surface.

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EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Normal epidermis of pectoral fin. Masson stain. × 150. Green filter (Wratten B).

Fig. 2. Normal epidermis of pectoral fin. Masson stain. × 500. Green filter (Wratten B).

Fig. 3. Hyperplastic epidermis of left pectoral fin of Specimen C. Masson stain. × 150. Green filter (Wratten B).

Fig. 4. Surface of hyperplastic epidermis of left pectoral fin of specimen C. Masson stain. × 500. Green filter (Wratten B).

Plate II.

Fig. 5. Cross section of ventral fin tumor of specimen A. Masson stain. × 32. Green filter (Wratten B).

Fig. 6. Cross section of right pectoral fin tumor of specimen D. Masson stain. × 47. Green filter (Wratten B).

Fig. 7. Cross section of left pectoral fin tumor of specimen B. Masson stain. × 44. Green filter (Wratten B).

Plate III.

Fig. 8. Basal region of hyperplastic epidermis of left pectoral fin of specimen C. Masson stain. × 500. Green filter (Wratten B).

Fig. 9. Enlarged section of Fig. 7. Tumor of left pectoral fin of specimen B, showing epithelial pegs penetrating into subdermal region. Masson stain. × 120. Red filter (Wratten A). Red filter used to bring out dermal connective tissues.

Fig. 10. Enlarged section of Fig. 9. Surface of tumor of left pectoral fin of specimen B. Masson stain. × 500. Green filter (Wratten B).

Fig. 11. Enlarged section of Fig. 9. Interior of tumor of left pectoral fin of specimen B. Masson stain. × 500. Green filter (Wratten B).

Plate IV.

Fig. 12. Enlarged section of Fig. 5. Portion of ventral fin tumor of specimen A, showing surface vascularization and form of epithelial cords. Masson stain. × 100. Red filter (Wratten A). Red filter used to bring out connective tissues surrounding blood vessels and epithelial cords.

Fig. 13. Enlarged section of Fig. 5. Basal portion of ventral fin tumor of specimen A, showing epithelial cords and basal remnants of fin rays. Masson stain. × 120. Green filter (Wratten B).

Fig. 14. Enlarged section of Fig. 5. Surface of ventral fin tumor of specimen A, showing necrotic surface and loose, spongy subsurface tissue. Masson stain. × 500. Green filter (Wratten B).

Fig. 15. Enlarged section of Fig. 13. Terminus of an invading epithelial cord of ventral fin tumor of specimen A. Masson stain. × 500. Green filter (Wratten B).

Plate V.

Fig. 16. Enlarged section of Fig. 13. Epithelial cords of ventral fin tumor of specimen A, showing incipient breakdown of basement membrane. Masson stain. × 500. Red filter (Wratten A). Red filter used to bring out connective tissue and basement membranes.

Fig. 17. Enlarged section of Fig. 13. Terminus of epithelial cord of ventral fin tumor of specimen A, showing breakdown of basement membrane and formation of flaring "flame" process. Masson stain. × 500. Green filter (Wratten B).

Fig. 18. Incipient pearl formation in ventral fin tumor of specimen A. Masson stain. × 500. Green filter (Wratten B).

Fig. 19. Incipient pearl formation in ventral fin tumor of specimen A. Masson stain. × 500. Green filter (Wratten B).

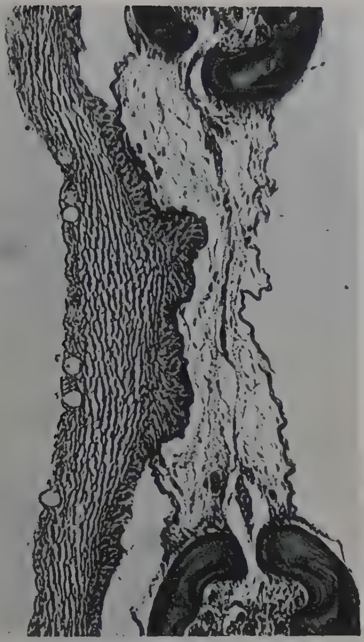

FIG. 1.

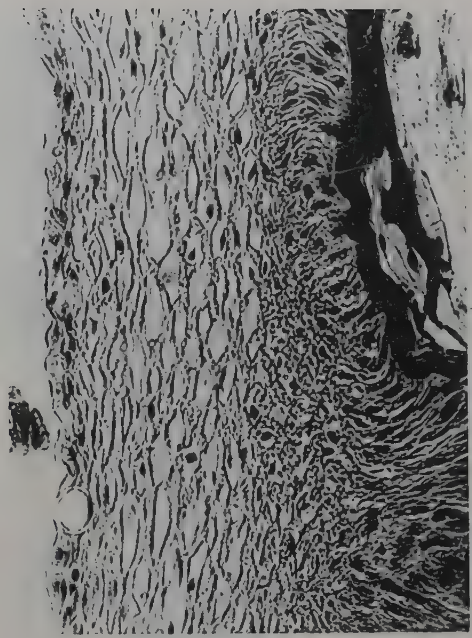

FIG. 2.

FIG. 3.

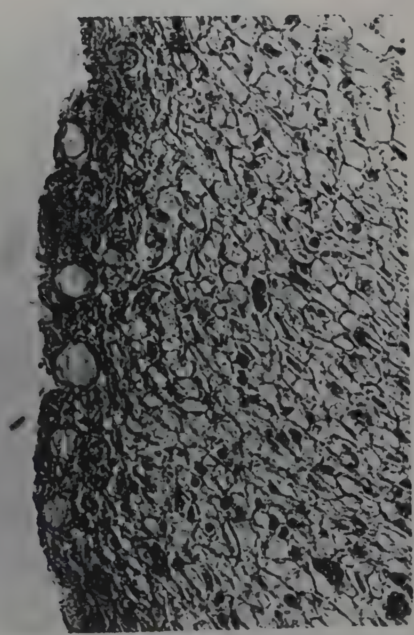

FIG. 4.

EPIDERMAL FIN TUMORS IN THE GOBIID FISH, BATHYGOBIUS SOPORATOR.

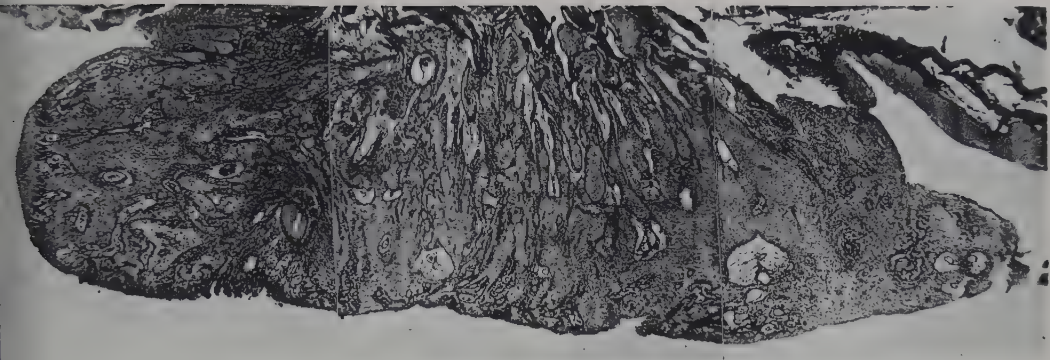

FIG. 5.

FIG. 6.

FIG. 7.

EPIDERMAL FIN TUMORS IN THE GOBIID FISH, BATHYGOBIUS SOPORATOR.

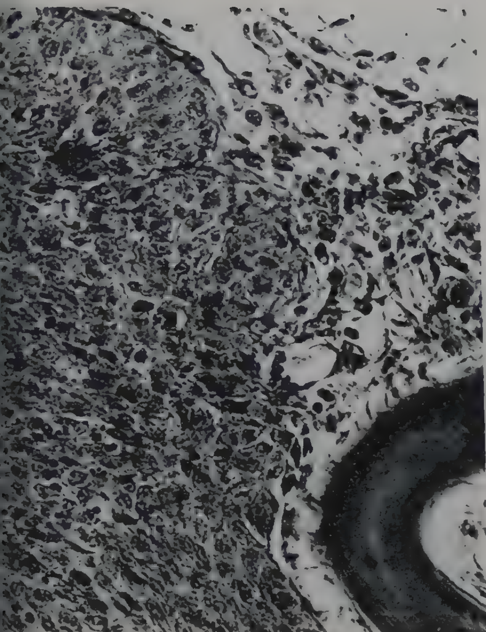

FIG. 8.

FIG. 9.

FIG. 10.

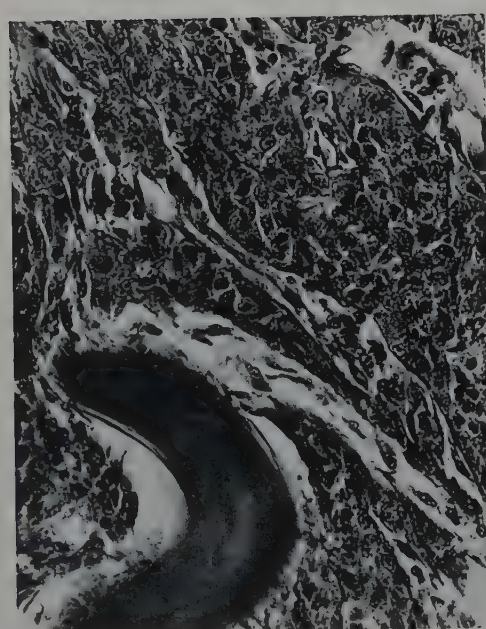

FIG. 11.

EPIDERMAL FIN TUMORS IN THE GOBIID FISH, BATHYGOBIUS SOPORATOR.

FIG. 12.

FIG. 13.

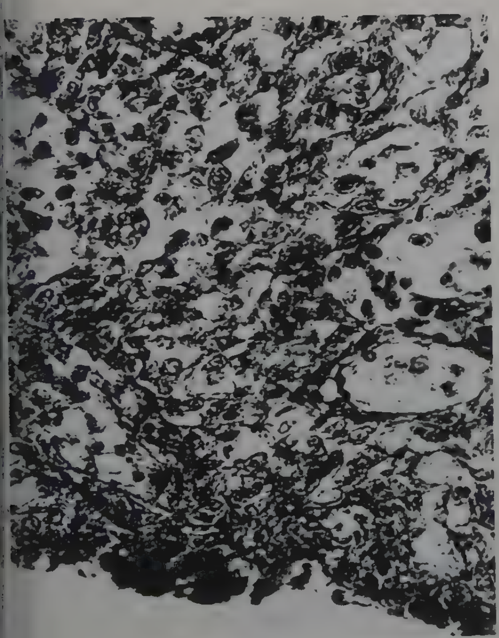

FIG. 14.

FIG. 15.

EPIDERMAL FIN TUMORS IN THE GOBIID FISH, BATHYGOBIUS SOPORATOR.

FIG. 16.

FIG. 17.

FIG. 18.

FIG. 19.

EPIDERMAL FIN TUMORS IN THE GOBIID FISH, BATHYGOBIUS SOPORATOR.

23.

A New Giant Toad from Southwestern Colombia.

George S. Myers & John W. Funkhouser.
Natural History Museum, Stanford University.

(Plate I).

While the junior author was in Ecuador in 1950, his friend, Mr. Rolf Blomberg of Quito, told him of reports of a giant toad supposed to exist in the vicinity of Nachao, Province of Nariño, about 90 kilometers northwest of Pasto, in southwestern Colombia. Mr. Blomberg went in search of this toad in late August, 1950, reaching Nachao by mule from Pasto. The region is near the western base of the western Cordillera, and probably has an annual rainfall of over 150 inches, to judge by records kept in northwestern Ecuador and Buenaventura.

Mr. Blomberg returned to Quito in September with a single example (the type described below) which he presented to Funkhouser for identification. Mr. Blomberg says that he reached Nachao at the height of the dry season and was told by the natives—all of whom seemed familiar with this toad—that the beasts were much more plentiful during the wet season, and that the specimen he secured was only half as large as the largest examples.

Nevertheless, the single toad obtained is over 20 centimeters in head-and-body length and weighed one kilogram when caught. It is, therefore, close to the largest record of *Bufo marinus* known to us, a 23 centimeter example in the American Museum of Natural History, New York. It would be strange if this first example obtained were near the extreme size for the species.

Determined to obtain larger specimens and upon an order from the New York Zoological Park, Mr. Blomberg returned to Nachao in May, 1951, during the rainy season. This time he obtained the three live paratypes which are now in the New York Zoological Park, and which were examined there by the senior author in July. These (two of which are pictured in *Animal Kingdom*, 54 (4): 124. 1951) are somewhat larger (largest 21.5 centimeters) than the first specimen, although according to a letter from Mr. Blomberg dated June 28, 1951, "The natives of the region . . . continue insisting that there exist considerably larger specimens."

Bufo blombergi, n. sp.

Diagnosis. — A *Bufo* of the *guttatus-glaberrimus* group, differing from *Bufo guttatus* and agreeing with *Bufo glaberrimus* in the rather broadly webbed toes. It differs from the east-Andean *glaberrimus* in the roughly areolated and evenly warty skin of the venter, the much smaller and less distinct tympanum, the much more concave loreal region, the broader head, the concave interorbital area, the longer lateral processes of the vertebrae, and the very large adult size.

Holotype. — Stanford 10419, a specimen 207 mm. in head and body length, from Nachao, Nariño Province, southwestern Colombia, at an altitude of about 550 meters, collected by Rolf Blomberg on September 11, 1950.

Paratypes.—Three recently received living specimens of approximately the same size, from the same area, and obtained by the same collector, were examined in the New York Zoological Park in July, 1951, and are hereby designated paratypes.

Description of holotype.—In general very similar in appearance to *Bufo guttatus* and *Bufo glaberrimus;* the upper surfaces smooth; the head very broad and shallow, without cranial crests except for a weak parietal crest; and the dorsal surface of the head and body light grayish in contrast to the dark sides of the body.

Head very broad and flat, its width just anterior to parotoids one-third of distance from snout tip to end of urostyle; without cranial crests except for a low parietal ridge. Interorbital broad, much broader than length of upper eyelid, shallowly but clearly concave, the concavity extending back to occiput. Snout somewhat rounded when viewed from above, the nostrils prominent, the line of the canthus rostralis concave, and the upper eyelids hiding the lips below them. From the side, the snout is bluntly rounded from the nostrils downward, projecting slightly beyond upper lip. Nostrils far forward, their distance from the eyes equal to the internarial space. Loreal area oblique, strongly concave, the canthus rostralis strong and prominent. Depth of subocular equals about two-thirds length of exposed part of eye. Distance from nostril to upper lip equals length of exposed part of eye. One or more large white tubercles at angles of jaw.

Tympanum very small; it is easily seen but its anterior part is indistinct structurally;

oval; vertically elongate and inclined forward above; its greatest depth equal to one-half the internarial space, to one-half distance from tympanum to corner of mouth, or to one-half length of exposed part of eye. Its distance from the eye is equal to almost twice the narrow (horizontal) diameter of the tympanum.

Parotoid glands large and prominent, roughly oval from above, extending far down on the sides to just above insertion of arm. From above, the parotoids bulge laterally, the broadest part of the body being at the posterior third of these glands; the broadest part of each gland, from above, is at the middle. From the side the glands are also roughly oval, the lowest part directly above the arm-insertion. Length of the gland equals the narrowest distance between the two. Cranial roof extending slightly out above the tympana just anterior to anterior tips of parotoids.

Arms not overly stout, their upper surfaces grossly areolated and thickly covered with low warts, the under surfaces somewhat smoother. A large, oval (almost round), median, palmar tubercle. A somewhat smaller, irregularly triangular inner palmar tubercle at base of first finger, this tubercle being connected with a large, rounded tubercle at mid-length of the first finger. Subarticular tubercles single; tips of fingers rather large and swollen, especially on first finger. Fingers without web. Second finger reaching base of swollen tip of first. Third finger longest, second and fourth about equal, reaching base of penultimate phalanx of third.

Legs only moderately stout and relatively long; the heels do not quite touch when femora and tarsi are at right angles with the body. Very little of the thigh is invested in the skin of the groin. Superior and outer surfaces of legs grossly areolate and thickly beset with low warts, like the arm. Length of thigh (vent to knee) goes into snout-tip to vent distance 2.33 times. Tibia (knee to heel) in the same 2.5 times. Length of foot in the same 1.8 times. Feet long and heavy. Toes fully webbed, the web reaching the bulbous tip of every toe except the fourth, but deeply excised between. (Web between third and fourth toes excised not quite as far down as penultimate phalanx of third.) Terminal enlargements of toes somewhat larger than those of fingers. Subarticular tubercles single. Two (and perhaps three) metatarsal tubercles, none corneous, the inner large and with a rounded, strongly projecting, free cutting edge, and the outer rounded and flat. Between these two is what appears to be another, rounded and flat, but this may be due to preservation. A strong metatarsal fold, which, however, fades out before coming close to heel.

Body flattened and dorsum broad, this flat area (caused by the great length of the lateral processes of the vertebrae) comparatively much broader than in *Bufo glaberrimus*. Dorsal skin, on this flat area, very smooth (except for the bony structure beneath), with neither appreciable areolae nor warts. An oblique bony ridge bounding each parotoid mesad, these two ridges much closer anteriorly than posteriorly. A median, anterior dorsal ridge, lower than the parotoid ones. Skin of sides abruptly warty and areolated below the broad dorsum. Underside coarsely areolated and beset with small smooth warts. Width of dorsum between ends of sacral processes slightly less than one-third distance from snout-tip to vent. Distance from lateral posterior corner of sacral process to vent almost as great as dorsal width at posterior margin of the parotoids.

Dorsum, down to mid-depth of parotoids and middle of sides, dirty yellowish-gray. This color also extends down over the sides of the head back to the parotoids. The lower half of the parotoids, and the lower sides, are dark, dull brown. Limbs dusky, the warts darker. Undersurface of body dirty yellowish-brown, the warts darker.

Measurements of holotype, in millimeters. —Snout to vent 207, width of head (in front of parotoids) 70, length of orbit 22, length of exposed part of eye 15, interorbital distance 27, internarial distance 16, subocular distance 12, greatest diameter of tympanum 8, length of parotoids (viewed from above) 40, depth of parotoids 25, width across vertebral processes (just behind parotoids) 65, length of femur (vent to knee) 80, length of tibia (knee to heel) 80, width of tibia 19, length of longest toe (measured from far side of metatarsal tubercle) 80, length of foot (heel to tip of longest toe) 112.

Discussion. — *Bufo blombergi* is undoubtedly a Pacific slope cognate of *Bufo glaberriumus* on the Atlantic Andean slope, and it is believed that the toads reaching 145 millimeters reported by Boulenger[1] as *Bufo glaberrimus* Günther from Cachabé, Northwest Ecuador, were *Bufo blombergi.* The Andes form an effective barrier to east-west distribution of tropical species, and as far as can be ascertained *Bufo glaberrimus* is a much smaller toad and has not been recorded west of the Andes except in the above mentioned report. The fact that the fame of these giant toads drifted out of so remote an area adds credulity to the assertion that *Bufo glaberrimus* does not approach the size of the toad herein described. If *Bufo glaberrimus* in its east-Andean range did reach such proportions, it seems that stories of it would filter out just as did the stories of the toad from Nachao.

It also seems likely that *Bufo anderssoni* Melin[2], later renamed *Bufo melini* Andersson[3] because the former name was preoccupied, from Taracuá, Río Uaupés, Brazil, is actually *Bufo glaberrimus*. Specimens of *Bufo glaberrimus* in the Stanford Museum

[1] *Proc. Zool. Soc. London*, 1898: 123.
[2] *Meddelanden Göteborgs Mus. Zool. Avd.* 88 (Handl.), Ser. B, 1 (4): 14, fig. 4a-b. 1941.
[3] *Arkiv. f. Zool.*, Stockholm 37A (2): 62. 1945.

from eastern Ecuador show intraspecific variation which would include the characters of *Bufo melini*. It is therefore suggested that this name be placed in the synonymy of *Bufo glaberrimus*.

Finally, it can be said that the authors are not entirely satisfied with the formal status we have accorded this new form because our sample has consisted of four gigantic toads with which we have been able to compare only rather small *Bufo glaberrimus* (although some at least of the latter appear to be adult). However, we are convinced that *Bufo glaberrimus* attains no such size as *Bufo blombergi* and that the present Andean heights effectively isolate the two populations. At the very least, *Bufo blombergi* is a very well defined subspecies if only in the point of size.

NOTE ON PARATYPES.

The three paratypes of *Bufo blombergi* are thriving in the New York Zoological Park as this paper goes to press. They will eventually be placed in the collections of the Department of Amphibians and Reptiles of the American Museum of Natural History, where they will be assigned AMNH Nos. A55319-21. The paratypes exhibit only slight variations from the holotype. The mid-dorsal color varies from light grayish-brown to dark chestnut brown. The measurements (in millimeters) of the largest individual are: snout to vent 230, width of head (in front of parotoids) 74, length of orbit 23, length of exposed part of eye 17, interorbital distance 30, internarial distance 18, subocular distance 13, greatest diameter of tympanum 8, length of parotoids (viewed from above) 43, depth of parotoids 28, width across vertebral processes (just behind parotoids) 71, length of femur (vent to knee) 91, length of tibia (knee to heel) 93, width of tibia 23, length of longest toe (measured from far side of metatarsal tubercle) 89, length of foot (heel to tip of longest toe) 125.—JAMES A. OLIVER.

EXPLANATION OF THE PLATE.

Fig. 1. Frontal and lateral view of two paratypes of *Bufo blombergi* Myers & Funkhouser. Note areolated area of venter.

Fig. 2. Lateral view of third paratype of *Bufo blombergi* Myers & Funkhouser.

FIG. 1.

FIG. 2.

A NEW GIANT TOAD FROM SOUTHWESTERN COLOMBIA.

INDEX

Names in **bold face** indicate new genera, species or varieties; numbers in **bold face** indicate illustrations; numbers in parentheses are the series numbers of papers containing the plates listed immediately following.